THE ENGINEER

OCTOBER 3, 1952

A Survey of Proposed African Railway Routes

A CONSIDERABLE amount of survey work which has recently been in progress in Africa forms the subject of three reports, addressed to the Secretary of State for the Colonies, which have just been published. These reports are concerned with the possibility of constructing several new railway routes, which were the subject of a preliminary reconnaissance in 1949. An exhaustive examination of the possible lines of economic development in the areas traversed by the most favourable route for a railway linking the Rhodesian and East African systems is made in a joint report by Sir Alexander Gibb and Partners and Overseas Consultants, Inc., of New York, whilst a third report, by the East African Railways and Harbours Administration, deals equally exhaustively with the construction problems and costs of the proposed railway link. It is pointed out in these reports that, in the past, development stood or fell on the construction of a rail line at the minimum cost. As traffic built up over the years, reconstruction to heavier standards became inevitable, often at considerable cost, and this has been the experience of almost every railway system in Africa. It may well be, one report states, that to-day the correct approach to the problem is to allow road transport to carry the burden hitherto borne by the low cost line and to postpone rail construction until traffic has built up. Furthermore, it is pointed out, with the exception of an area in South-West Tanganyika, development must be based almost entirely on agriculture (the importance of increased food production is emphasised as the principal factor) and those responsible would be wise to consider whether some part of the funds which would be spent on rail construction and on bearing initial losses could not be better devoted in the early phases of development to high-grade all-weather roads, to the promotion of agricultural development, and possibly to the lowering of road freights by government assistance. These steps, it is said, would be as helpful in building up food production as would be a railway, and would cost very much less. The rail construction could thus be postponed until the economic position justified it. However, the proposed routes were considered to be practical to construct, though expensive, from the engineering standpoint, and of considerable strategic and political importance.

The Royal Research Ship "Discovery II"

THE Royal Research Ship "Discovery II," which recently returned from a successful cruise devoted mainly to experiments with new methods of sampling and observing the oceanic fauna, including the use of the Admiralty's underwater television equipment, sailed again from Plymouth at the end of last week to make further researches in marine physics. The Admiralty states that the ship's built-in wave recorder has now stood the test of four months' seagoing, and has several times recorded the growth of waves from calm to heights over thirty feet. The recorder is now to be used again to study the development of wave patterns. Information about the growing heights and lengths, and phase relationships will be recorded at the same time as the wave profile. Measurements will be made of the smallest roughnesses on the windward and leeward sides of the waves, and of the speeds and depths of the wind drift currents. It is hoped to gain more knowledge of wave generation and the transfer of energy from the atmosphere to the oceans. Information about the decrease of wave action with depth will be obtained from simultaneous wave recordings with a pressure measuring instrument and an inverted echo-sounder laid side-by-side at varying depths on the sea bed. The effect of tidal streams on waves will also be studied. Other aspects of the energy transfer to the ocean will be studied by water sampling and sensitive temperature measurements. The ship will work for a month off the western end of the English Channel and the Bay of Biscay. It is expected that she will then be laid up for a time owing to shortage of funds.

The National Smoke Abatement Society

THE annual conference of the National Smoke Abatement Society was held at Portsmouth last week under the presidency of Alderman Professor F. E. Tylecote. Professor Tylecote delivered his presidential address on Wednesday, September 24th, the major portion of it being an informative historical survey of pioneering efforts to reduce the smoke nuisance. On the same day, the third Des Voeux memorial lecture, entitled "Smoke and the Law," was given by Mr. W. R. Hornby Steer, LL.B. In the course of it, Mr. Hornby Steer suggested that the urgency of the need for more effective control of the sources of smoke nuisance was such that we could not afford to wait until such time as the ordinary local government boundaries might be revised to suit the needs of modern requirements, but that consideration of the boundaries of areas for purposes of smoke control was a matter which brooked no delay. But, Mr. Hornby Steer continued, experience of cities in which advance had been made in smoke abatement showed that the best results needed more than the existence of Acts of Parliament and by-laws; they required the active co-operation of owners and business executives who were in a position to determine the cause of smoke from their plants. The degree of smoke regulation or air pollution control, Mr. Hornby Steer added, would depend in large measure on the temper of public opinion in the area. In the long run, it was the force of public opinion that determined the nature and degree of control which would be tolerated by a free people and it was of importance that public opinion should be directed in the right way. The papers presented to the conference as "progress reports" included "A Review of Fuel Research Station Investigations," by Dr. E. T. Wilkins, and "A Report from the U.S.A.," by Mr. Henry Burns. On the final day of the conference—Friday, September 26th—a paper entitled "Pollution Problems in the Iron and Steel Industry," was presented by Professor R. J. Sarjant.

Institution of Naval Architects' Autumn Meeting

AT the invitation of Associazione Italiana di Tecnica Navale, the Autumn meeting of the Institution of Naval Architects is being held in Italy in Genoa, Rome and Naples. The delegates assembled in Genoa by Thursday, September 25th, and the formal opening of the meeting on Friday, September 26th, was preceded by a visit on Thursday afternoon to the "Istituti di Architettura e di Costruzione Navale" of the "Universita degli Studi" at the Villa Cambiaso. We were welcomed by Professor Carlo Cereti, the Rector of the University of Genoa, and then the Director of the Institute of Technology, Professor Agostino Capocaccia, went on to say something about the Villa Cambiaso, which was built in the sixteenth century. He gave a general outline of the work of the Institute, which holds courses in most engineering subjects and is attended by 500 students, eighty-six of which are students attending the combined naval architecture and mechanical engineering course. Lord Runciman briefly replied on behalf of the Institution of Naval Architects, and then Colonel Dr. Ing. Luigi Tursini gave a short account of the researches of Leonardo da Vinci on naval matters, illustrated with lantern slides of the original drawings and sketches. While in the Institute we visited the laboratory to inspect the closed-circuit tank which has been installed recently and which was demonstrated by Professor Alfio Di Bella. The tank, which measures 12·24m in length by 4·24m in breadth overall, consists of a channel 1·20m wide and 1·20m deep in two straight lengths of 7·78m joined by semi-circular ends. The water in the tank is circulated by a propeller and the ship model is held motionless so that its behaviour can be noted and the resistance measured. The other main exhibit was a tank some 45m in length by 3·80m wide by 1·20m deep, which is fitted with a wave-making machine and equipped with towing gear. From the Institute we proceeded to the town hall where the deputy mayor gave an address of welcome and afterwards we had the opportunity to see some of the tapestry and paintings hung in the rooms of this ancient building.

An Exhibition of Inventions

THE Institute of Patentees has announced this week particulars of an exhibition of inventions, which is to be held from February 18th to 28th at the Central Hall, Westminster, S.W.1. This exhibition—which will have the title "Modern Inventions and New Ideas"—is to be conducted on similar lines to the displays of new inventions organised by the Institute prior to the war. There will be a trade section for items already on the market, but it is stated that the principal object of the exhibition is to provide opportunity for the display of inventors' models. Although the Institute of Patentees is not directly responsible for the organisation of the exhibition, it has readily undertaken to direct and supervise the inventions section, which will occupy the whole of one floor. The hope is expressed that the number and quality of the inventions submitted will be such that the public and industry itself will be impressed by the amount of inventive talent to be found in this country. Fuller information about the exhibition can be obtained from the Institute of Patentees, 207–208, Abbey House, Victoria Street, London, S.W.1.

Water Pipes for Agricultural Uses

JUST over two years ago the Ministry of Health set up a working party—under the chairmanship of Mr. H. W. Coales, M.I.C.E.—to make a study of the different kinds of small-diameter water pipes used in connection with rural water supplies, particularly by farmers. The report of the working party has been published this week by H.M. Stationery Office, for the Ministry of Housing and Local Government which now bears responsibility for water supply matters. When the working party was formed it was not given any precise terms of reference, and at its first meeting it decided that it would deal only with pipes of 2in diameter or less for outdoor use. The report includes information about the nature, cost and properties of the different kinds of small pipes which might be used for rural water supplies, special emphasis being put on the need to select pipes resistant to corrosion caused either by the nature of the soil in which they are laid or by the water which they carry. Among the conclusions reached by the working party are that galvanised steel pipes can be used without risk for non-corrosive waters and soils, but should not be used where rapid corrosion of ferrous metals is to be expected; that steel pipes coated internally and externally with bitumen and sheathed externally are likely to withstand corrosive conditions satisfactorily; and that copper tubing can be used under all conditions except to carry very acid water or in exceptionally corrosive soils. The report says also that asbestos cement pipes, if of 1¼in diameter or over, are suitable under all conditions except in highly sulphated soils, provided metal joints and bolts are adequately protected against corrosion and the pipes are evenly bedded. It is added that polythene pipes may be expected to prove satisfactory for cold water supplies in all soils and for all waters if made to British Standard Specifications which, it is understood, are now being prepared.

The International Machine Tool Exhibition at Olympia

No. II—(*Continued from page 409, September 26th*)

THE International Machine Tool Exhibition at Olympia closes tomorrow Saturday, October 4th. We continue below our descriptions of some of the machines and equipment which are being exhibited.

THOMAS RYDER AND SON, LTD.

The universal machine tool, illustrated in Figs. 25 and 26, was originally designed to Admiralty specification by Thomas Ryder and Son, Ltd., of Bolton, Lancs, for repair ships, and is now built for general-purpose work where floor space is limited. This machine, incorporates a lathe, a sensitive drilling machine, a universal milling machine, a universal grinding machine, and a tool and twist drill grinder.

Both the lathe and milling machine are powered by the same 6 h.p. motor. The drive is transmitted by vee belts to a common shaft from which it is taken through clutches and similar nine-speed gear trains to the lathe and milling machine spindles. These two sets of gearing, together with the lathe feed screwcutting gears, are housed in the main body of the lathe headstock. The lathe spindle and both the vertical and horizontal spindles of the milling machine are all mounted on similar taper roller bearings, and each spindle has a reverse gear and a brake. Stopping and starting of the machines is by lever-operated clutches.

The 6½in sliding, surfacing and screwcutting lathe admits 30in between centres and has a gap bed which allows a swing of 10½in. It has nine spindle speeds ranging from twenty-one to 533 r.p.m., and twelve feeds from 0·0056in to 0·0391in per revolution sliding and 0·0028in to 0·0195in per revolution surfacing. Change wheels are supplied to enable a wide range of screwcutting in metric and inch threads, and with even change wheels twelve threads ranging from three and a half to twenty-four T.P.I. can be selected by gear change levers. The change wheel compartment is situated on the front of the lathe headstock and the wheels are readily accessible as their shafts are arranged at right angles to the lathe spindle.

The universal milling machine has both a vertical and a horizontal spindle. The vertical spindle is mounted in a swivel head that can be swung to any required angle, and it permits a wide variety of angular milling operations to be carried out without need for complicated set ups. This head also carries the support for the horizontal arbor. The table has a working surface of 40in by 10in and its traverses are 23in longitudinal, 7in transverse and 13in vertical. Nine spindle speeds are obtainable ranging from 21 to 533 r.p.m., and four feeds varying from ½in to 10in per minute.

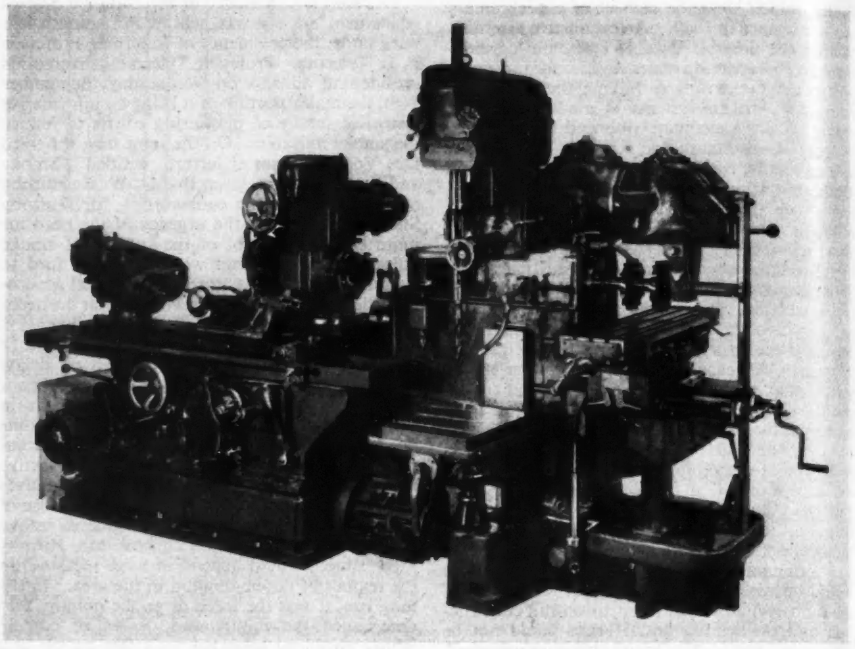


Fig. 26—Grinder Side of Universal Machine—Ryder

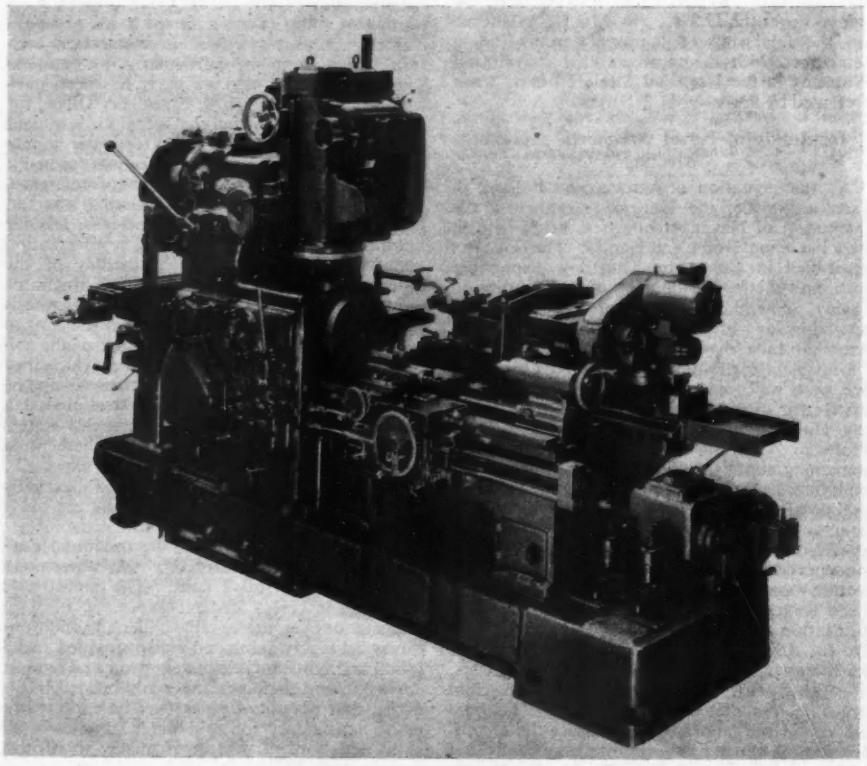


Fig. 25—Lathe Side of Universal Machine—Ryder

The sensitive drilling machine is separately driven by a 2 h.p. motor and changes of speed or feed are quickly obtained through sliding gears and hand or automatic feed can be used. It takes drills up to 1¼in diameter and the distance from the spindle to the centre of the column is 12¼in. The maximum distance from table to spindle nose is 31in. There are nine spindle speeds, from 85 to 1220 r.p.m., and four feed rates of 0·0055in to 0·0162in per revolution.

The universal grinding machine is designed for surface, internal and external cylindrical grinding and it has a swivel table for taper grinding purposes. A 2 h.p. motor drives the table through a gearbox and clutch, the gearbox being supported on a rubber mounting and coupled to the grinder by means of a flexible coupling. The wheelhead and workhead are self-contained units driven by 3 h.p. and ¼ h.p. motors, respectively. To prepare the grinding machine for use, the wheelhead adaptor base, which is normally clamped to the grinder table, is transferred to the lathe bed where it is coupled to a vertical shaft which transmits the feed motion to the head. The wheelhead can then be lifted from its base on the lathe headstock and mounted on the adaptor base. The lathe and the grinder cannot therefore be operated at the same time.

This grinding machine takes work up to 10in diameter and 24in long, and its

traverses are longitudinal 24in, transverse 7in and vertical 14in.

The standard design tool and twist drill bench grinder is driven by a ½ h.p. motor.

The complete machine is mounted on a fabricated steel main bedplate, which is used as a suds tank and contains cupboards for tool storage. The suds system for the grinding machine is entirely separate from that for the rest of the machine and provision is made to settle abrasive matter in easily cleaned compartments.

Churchill-Redman, Ltd.

One of the new machines to be seen upon the stand of Churchill-Redman, Ltd., of Halifax, is the 20in by 60in lathe illustrated in Fig. 27.

This machine is designed on particularly clean lines with well-arranged controls, and a good range of speeds and feeds to meet modern production requirements. It is driven by a 20 h.p. motor and the headstock gearing gives eighteen forward speeds from 15 to 1000 r.p.m., and six reverse speeds. The main spindle, which is bored 2¼in diameter, runs in opposed Timken taper roller bearings at the front, and is supported by roller bearings at the centre and rear. Drive is transmitted through a hydraulically operated clutch and spindle braking is provided.

The totally enclosed gearbox driven by the end train gives thirty changes of sliding and surfacing feeds—0·005in to 0·038in sliding and 0·0025in to 0·019in per revolution surfacing. For additional course pitches above the available range of thirty-four, 2½ to 19 t.p.i., a four-to-one step-up ratio can be provided. The saddle is located on the unequal front vee of the bedways, and an apron of double-wall construction has the controls for all sliding, surfacing and screw-cutting motions effectively interlocked.

A semi-automatic hydraulically controlled profiling lathe exhibited swings 6in over the saddle between 40in centres. Its three-speed change headstock gives two low speeds for rough turning and one high speed for finishing. By using a two-speed main motor and four pick-off gears twenty-four spindle speeds from 130 to 1000 r.p.m. are made available.

A hydraulic cylinder used for carriage feed provides infinitely variable feed rates from 0 to 17in per minute, and a quick-power motion is available for both directions of carriage movement.

The tool slide, which is suitably positioned to enable square shoulders to be turned, is also arranged to feed into depth automatically and is automatically relieved at the end of the cut. The template or master used when profiling is held between centres at the rear of the machine, and the tracing finger which engages with the master and controls the movement of the tool slide is housed underneath the slide. The whole machine is controlled by one lever and one pedal. This pedal operates chuck opening or closing and the tailstock spindle advance or return movements, and the lever starts the machine cycle, the knock-off being automatic.

A new 24in shaping machine being made by the firm is illustrated in Fig. 28. In this machine drive from the 10 h.p. motor is transmitted from a heavy pulley, which acts as a flywheel, through a multi-disc clutch. The length of ram stroke is indicated on a direct-reading dial and a range of eight stroke rates from 9 to 117 per minute is available. If required, the swivelling tool slide can be fitted with an automatic feed, giving feed rates up to 0·060in per stroke in each direction.

The cross slide is normally locked to the vertical ways on the body and the square slide is fitted with four opposed taper gibs to maintain adjustment. A separate heavy box table is supported on the top face of the slide and has a front support to resist downward and outward deflection.

Power feed is provided for the square slide, giving eleven changes of feed in either direction from 0·010in to 0·170in per stroke. These feeds are controlled by a single lever with reference to a direct-reading dial, and can be changed whilst the machine is running. Rapid power operation is provided in each direction of the square slide and can be operated at any time and always in the opposite direction to the feed which is engaged.

A vertical rapid power operation provided to the cross slide considerably eases height settings for different components, and it is operated by the same controls as those for the power motion to the square slide.

The gear cutting equipment exhibited includes one of the firm's "Red Ring" gear shaving machines for finishing gears from 1in to 12in pitch diameter to a high degree of accuracy. In this machine the gears are finished by a crossed axis rotary shearing method, designed to correct gear cutting errors of index, helix angle, tooth form, and eccentricity.

Birlec, Ltd.

Heat treatment equipment in many forms is made by Birlec, Ltd., of Erdington, Birmingham, and the main items it is

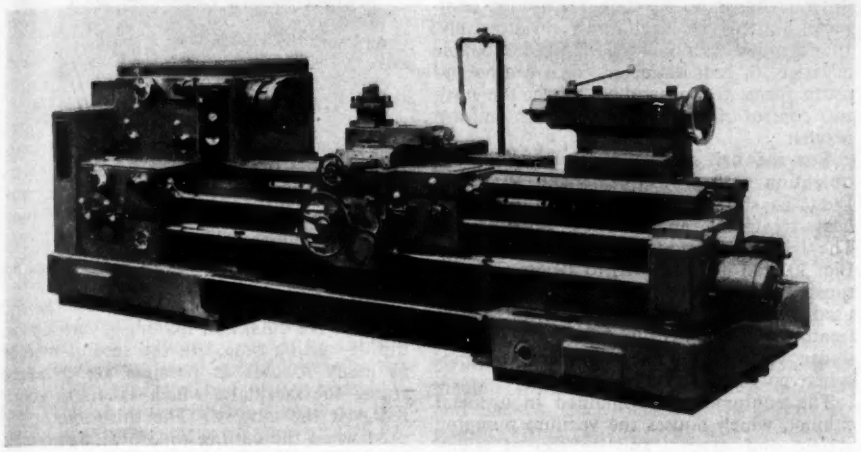


Fig. 27—20in × 60in Lathe—Churchill-Redman

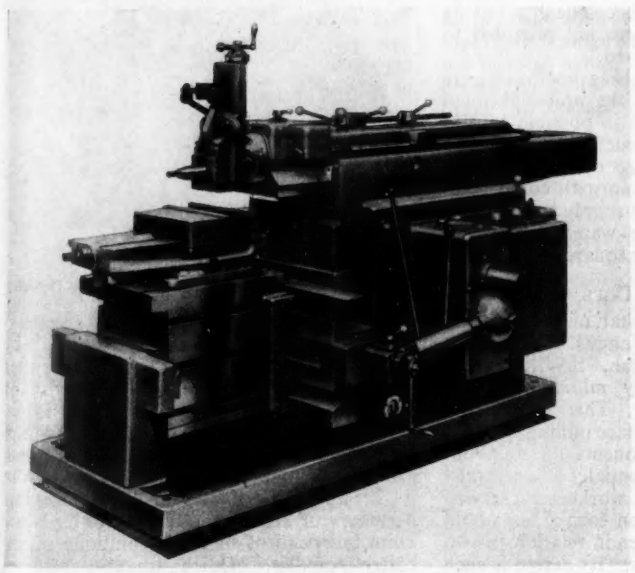


Fig. 28—24in Shaping Machine—Churchill-Redman

Fig. 29—Shaker Hearth Furnace—Birlec

exhibiting are designed to indicate in some degree the increasing mechanisation now being used for charge handling in furnaces.

A 20kW shaker hearth furnace shown has been developed for the continuous heat treatment of small and medium sized carbon steel components. Both hardening and tempering models of this design of furnace have been made in standard sizes ranging from a 6in to a 24in wide furnace. In these units progression of the charge is effected by shaking it through the furnace on a solid hearth and, in case of the hardening equipment, continuous conveyors through the quench tank can also be provided when necessary. The inherent advantages of this form of progression are that it can easily deal with even the smallest industrial components without sticking and that as the hearth remains in the heated chamber, no heat loss is caused by a belt moving through and out of the furnace. By the use of an atmosphere derived from a Birlec

Fig. 30—Vacuum Furnace—Birlec

endothermic atmosphere generator (described below) bright hardening without decarburisation can be carried out.

A typical furnace unit of this design is illustrated in Fig. 29. It consists of an electrically heated chamber lined with insulating refractory material and encased in mild steel plate. Standard heavy-section nickel chromium elements are located in slotted bricks in the roof and hearth and a further element is arranged on the end wall facing the quench tank chute to ensure that temperature is fully maintained at the point of discharge. Individual elements can be easily removed through the side walls.

The shaker mechanism is housed in the forepart of the furnace and the electrical gear is included within the main furnace framework, thus forming a compact equipment requiring minimum factory floor space.

The shaker hearth is a grooved or plain nickel-chromium plate, which is agitated at predetermined intervals causing the charge to move through the heated furnace chamber at a controlled speed. Its mechanism can be regulated to operate from every 3 seconds to 2½ minutes, the time spent by a charge in the 20kW furnace being adjustable from 2½ minutes to 2 hours.

The endothermic atmosphere generator on the stand enables the shaker hearth furnace to be operated for the bright hardening of carbon steel components. This application is perhaps the most important of the many uses of the endothermic generator, although it is commonly used, in conjunction with suitable furnaces, for the bright annealing of carbon, restoration of hot rolled steel products, the patenting of carbon steel wire, copper brazing of carbon steel assemblies, for sintering processes and as a carrier gas in gas carburising furnaces. The 250 cubic feet per hour capacity unit shown is the smallest in the range of standard units up to 3000 cubic feet per hour rating, the larger sizes of generator being heated by town's gas.

A gear hardening machine is exhibited as a typical example of the automatic equipment made for high frequency induction heat treatment. This machine is used for the surface hardening of the wearing surfaces on individual gear teeth and incorporates an indexing mechanism to permit the complete gear to be dealt with progressively. Interchangeable inductors and fixtures enable a variety of gear diameters, face widths and tooth forms to be handled, whilst the positive control of all functions ensures uniform results.

For the first time the company, in co-operation with British American Research, Ltd., is showing a vacuum furnace for heat treatment and melting applications. The laboratory model unit is illustrated in Fig. 30, and it is designed to attain temperatures of up to 2000 deg. Cent. It can be used for melting, degassing metals, heat treatment, and sintering and can be operated under vacuum or under controlled atmosphere conditions.

The equipment is contained in a metal cabinet, which houses the vacuum pumping system and gauges, and on top of which is the furnace contained in a vacuum enclosure. The furnace itself is heated by a molybdenum or tungsten resistance element wound around the crucible, the whole being surrounded by a stainless steel sleeve. The largest size of crucible which can be accommodated in the unit shown has a capacity of 19 cubic inches (6in high and 2in diameter), and, if half-filled, the crucible contains 3 lb or 4 lb of steel, for which adequate melting capacity is available. The heating elements are readily replaceable and do not embody any refractories, thus giving improved vacuum conditions and eliminating the risk of contaminating critical melts. The vacuum system consists of a new oil diffusion pump, backed by a Kinney mechanical roughing pump and suitable gauges are provided to measure the vacua obtained.

Heat treatment or melting operations are controlled from outside the unit and when melting, for example, it is possible to add to the melt, stir it, or pour it under vacuum or controlled atmosphere conditions. The unit operates from a normal commercial 415V, three-phase, 50 c/s supply and requires a 4 gallons per minute water flow at an inlet pressure of 15 lb per square inch.

Dowding and Doll, Ltd.

A machine of somewhat unusual design, exhibited by Dowding and Doll, Ltd., of Greycoat Street, London, S.W.1, is the "Ahcol Senior" rotary milling machine, illustrated in Fig. 31. This machine is designed for side and for face milling castings, forgings and bar components up to about 7in cube. It consists essentially of a centrally disposed, double-ended workhead carrying a faceplate or fixtures on each side to hold and rotate the workpieces in relation to two independent cutter heads. Its design is such that only one operator is needed for the continuous milling of two separate components, or for carrying out two operations consecutively on the same component, or for the double production of the same operation on one component.

In this machine any of three methods can be used for holding workpieces. First, two or more hand or power-operated fixtures can

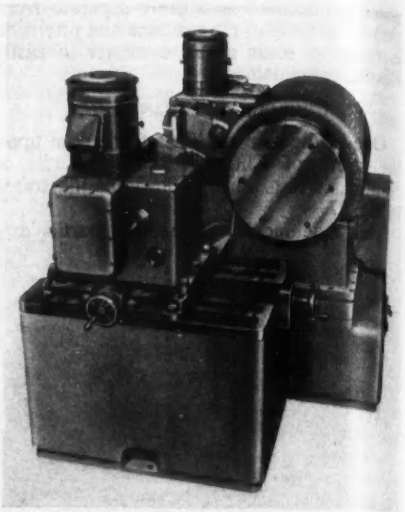


Fig. 31—Rotary Milling Machine—Dowding and Doll

be mounted on a faceplate with fast traverse between the cuts, and loading is carried out during cutting time. In the second method as many fixtures as possible are arranged round the faceplate, which is continuously fed past the cutters. The third method is used when the cutting time of a component is too short for hand clamping. The parts are held in spring-operated fixtures, in which a swivelling swashplate, operated by side-pressure rollers, gives automatic side grip.

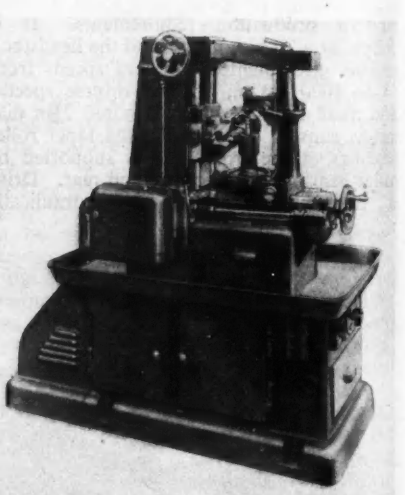


Fig. 32—Universal Gear Hobbing Machine—Dowding and Doll

If required, end grip can be supplied by pressure pads mounted on the overarm cutter spindle support. Loading is done whilst the faceplates are feeding past the cutters.

The heavy workhead is driven by a 1 h.p. feed motor through pick-off gears, which give a range of ten cutting feeds ranging from 0·69in to 61in per minute on a faceplate periphery of 21in diameter. These feeds are quite independent of the revolutions of the cutter spindles. Quick traverse between cutting is obtained from a ¾ h.p. motor, which superimposes a fast drive on to the

feed shaft, overrunning through a cam and roller freewheel. This fast traverse motor is cut in and out by adjustable trip dogs located round the workhead drum in phase with the work fixtures.

The two cutter heads are each independently motor driven through gearing giving a choice of twenty spindle speeds ranging from 28 r.p.m. to 675 r.p.m. Each head is mounted on a compound slide giving longitudinal and transverse adjustment by lead screw for setting purposes.

The "Polygon" universal grinding machine, illustrated in Fig. 33, is designed, in addition to the usual straight and taper internal and external grinding operations, to generate or finish grind curvilinear polygonal profiles internally and externally to a high degree of accuracy. It has a centre height of just under 7in and takes 31½in between centres. The machine incorporates a hydraulic control system for the table and wheelhead movements, and a single lever is used to control table traverse, rotation of the work and coolant flow.

For the grinding of eccentric or polygonal profiles on work a gyratory motion is imparted to the axis of the grinding wheel by a mechanism built into the head. Gyratory motion of the wheel is controlled by an eccentric, which imparts to the spindle two sinusoidal motions perpendicular to each other, through two sliding members, one horizontal, the other vertical. The horizontal motion is directly controlled by the eccentric whilst the vertical motion is reversed and transmitted from one sliding member to another via a multiplying lever giving four different ratios. Changing from one ratio to another is done through a four-speed change gearbox controlling the eccentric. Ratios 1 : 1, 1 : 2, 1 : 3, 1 : 4 respectively generate eccentric elliptical, triangular or square profiles. The wheel spindle is carried on articulated links, through which its movements are made possible. The driving eccentric incorporates two bushes, which are thrown off centre and conjugated. The position of the smaller bush can be varied as required inside the larger bush to give a continuous variation of throw of the complete eccentric between 0 and 0·315in, with reference to dial indicators on the grinding head.

A group of gear hobbing machines on the stand includes the Dowding "V8" universal machine for spur gears, helical gears, worm-wheels, splines and ratchets, illustrated in Fig. 32. This machine is designed for work up to 8in diameter, 7in face and 14 D.P. The work spindle of this machine is driven through a phosphor-bronze master worm wheel and a ground worm mounted in journals independent of its splined drive shaft. Means of axial and radial adjustment are fitted to eliminate float and backlash of the worm.

The hob spindle is driven through pick-off gears giving ten speeds from 61 r.p.m. to 246 r.p.m. or 91 r.p.m. to 369 r.p.m. A balanced flywheel is fitted at the lower end of the fast vertical main shaft of the hob drive unit to give smooth cutting. The hobbing head is carried on a vertical traversing saddle on which the head can be swivelled through 220 deg. to accommodate left or right-hand helical gears.

A cam-operated infeed unit fitted to the machine gives rapid approach, adjustable feed rates and quick return to the loading position of the table. It makes it possible to machine worm wheels of medium helix angles and narrow faced helical gears rapidly by plunge cutting.

Drummond Asquith (Sales), Ltd.

Amongst the plant of British manufacture exhibited on the stand of Drummond Asquith (Sales), Ltd., King Edward House, New Street, Birmingham, 2, is a new lathe made by Oldfield and Schofield, Ltd., with 12½in centres for heavy duties and 15in centres for medium duty.

The drive to the fast headstock of this lathe (Fig. 35) is taken through vee belts from a 15 h.p. motor and the gear drive gives twenty-four spindle speeds, from 7 to 500 r.p.m. The saddle of the machine has an ample bearing surface on the bed and its sliding, surfacing and screwcutting motions are operated by a single lever. A rapid power longitudinal traverse motion is driven by a 1½ h.p. motor at one end of the bed. A Norton feed box gives twenty-eight feed and screwcutting changes, the sliding feeds being 16 to 224 cuts per inch and the surfacing feeds from 35 to 488 cuts per inch. When using a coarse pitch motion on the slow speed range the above ranges are multiplied by nine.

The W.S. "Pitchmaster" thread rolling machine to be seen on the stand is designed for high production thread rolling on high tensile steel components and it can be arranged for hand or semi-automatic feeding. The roll spindles of the machine are driven by a 3 h.p. motor and the feed mechanism is powered by an independent 1 h.p. motor. The feed is by cam, operating a slide mounted in large ways and carrying one thread roll. Fine adjustment is provided for setting forward the roll. All size adjustments are made from one graduated collar. The cycle times obtainable with full or semi-automatic operation vary from 3·4 to twenty-three seconds in duration. On the standard machine threads up to 2in long and from $\frac{5}{32}$in to 1½in diameter can be rolled. The machine can also be adapted to rolling threads on continuous lengths at a speed of 17in per minute.

The Continental machines include the Ohler hydraulic saw, illustrated in Fig. 34. As can be seen, these machines are of very rigid construction and consist of a heavy base with two heavy ground columns surmounted by cross-head to form a rigid frame. The saw carriage moves up and down the long cylindrical guide columns,

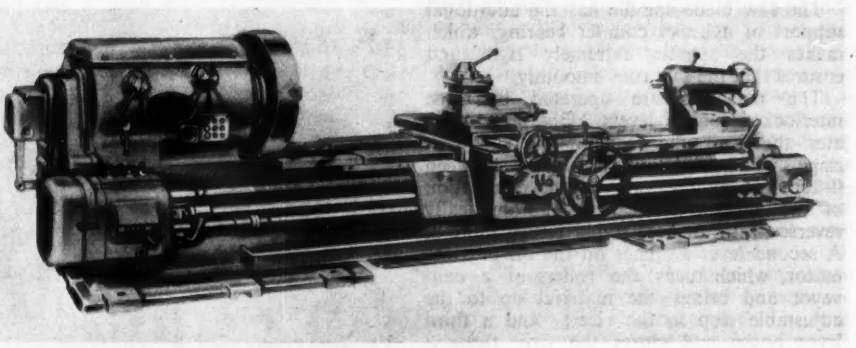


Fig. 35—Heavy-Duty Lathe—Drummond Asquith

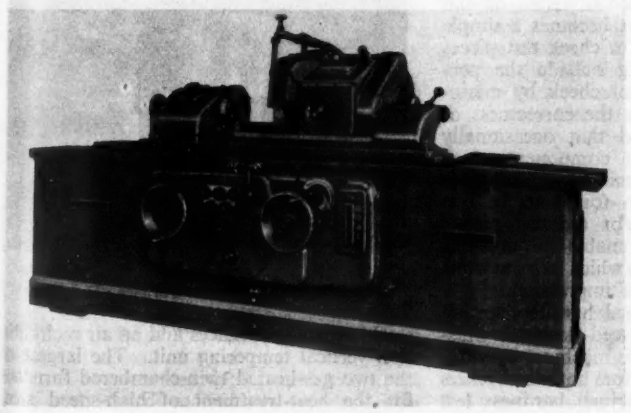


Fig. 33—Universal Grinding Machine—Dowding and Doll

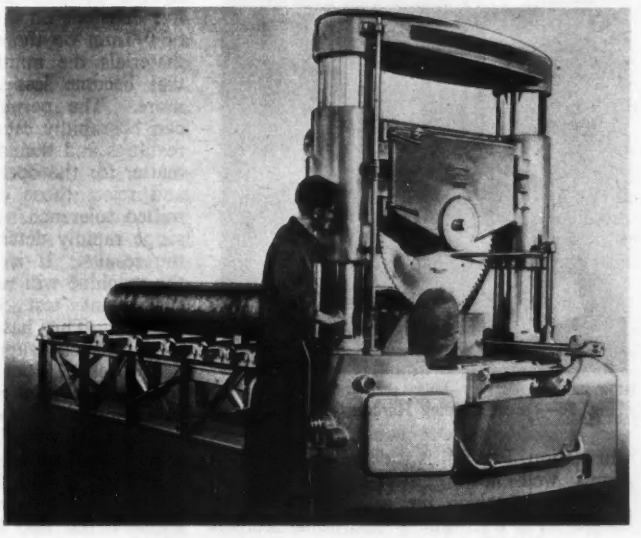


Fig. 34—Sawing Machine—Drummond Asquith

and all cutting pressures are confined within the closed frame of the machine. A hydraulically-operated vice is set directly below the centre line of the saw, so that the shortest possible cutting traverse is obtained, and at the same time coolant, which is fed from both sides of the saw blade, runs into the cut and remains there. As the saw is always cutting in the coolant high-cutting speeds can be used without detriment to the saw blade.

The saw blade spindle has the additional support of a heavy counter bearing, which makes the spindle extremely rigid and ensures that the saw runs smoothly.

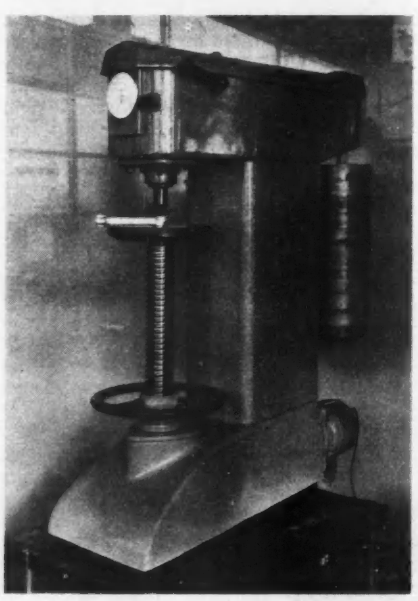
The machines are operated by three interlocked control levers. One lever operates the hydraulic feed of the saw carriage, which is infinitely variable between 0–20in per minute, and at the completion of the cut the saw carriage automatically reverses with an accelerated return motion. A second lever switches on the oil pressure motor, which turns the rollers of a conveyor and brings the material up to the adjustable stop in the vice; and a third lever opens and closes the vice, through hydraulic means. The machine exhibited is suitable for material up to 10in in diameter and, through a gearbox, has a range of six cutting speeds.

A group of Drummond automatic and semi-automatic "Maximatic" and "Maximiner" lathes is arranged to show some of the classes of work for which these well-known multi-tool machines can be used. There are also four Drummond "Maxicut" gear shapers set up for shaping spur and helical gears, as well as a wide range of Continental machines of different makes.

W. and T. Avery, Ltd.

The testing equipment to be seen upon the stand of W. and T. Avery, Ltd., of Birmingham, includes a newly designed direct-reading Brinell hardness testing machine suitable for use in the production shop.

This machine, as can be seen from the



[Fig. 36—Direct Reading Hardness Tester—Avery

illustration, Fig. 36, is a development of the firm's well-known power-operated Brinell machine, in which the load is applied by means of a lever and proportional weights acting on a frictionless penetrator, and the work of applying and removing the load is performed by a motor-operated hydraulic pump and ram controlled by a small lever. It remains a true Brinell machine inasmuch as the impressions produced are true Brinell impressions in accordance with B.S.S.240, Part 1, and can be read by microscope at any time. In addition, however, the machine is provided with a dial gauge which gives a depth reading which can be converted to a Brinell figure. The depth recorded is not the depth from the surface to the bottom

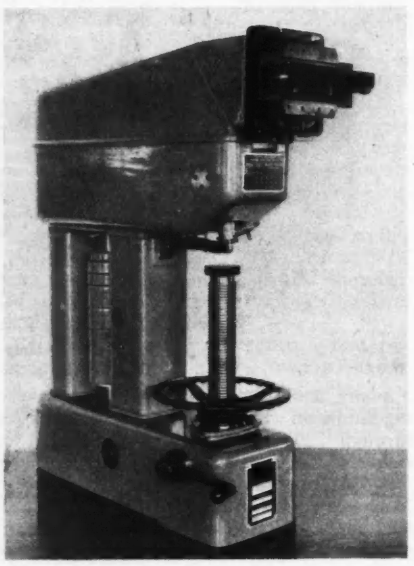


Fig. 37—Visual Hardness Tester—Avery

of the impression but the difference between the depth of an initial impression under a load of 250kg and the final depth under the major load of up to 3000kg. The depth is read after the major load is removed so that frame and test piece distortions do not confuse the result. It will be seen that the system is similar to that used on the Rockwell test nut, but it is pointed out by the makers that, due to the greater loads and greater depth of penetration, certain of the difficulties associated with this form of test are not experienced.

Tests with this machine are stated to show a great measure of reproducibility and the speed and ease of operation enable upwards of 300 tests an hour to be maintained without difficulty. For an average Brinell hardness of 250 where $P/D^2=30$, five divisions on the dial equal one division of 0·1mm on the microscope. For harder materials the number of divisions on the dial become less and for softer material more. The permitted hardness tolerance can be rapidly established in terms of dial readings and thereafter it becomes a simple matter for the operator to check test pieces and reject those coming outside the permitted tolerance. A spot check by microscope rapidly determines the correctness of the results. It is found that occasionally the machine will reject a component which subsequent test by microscope proves correct. This has been found to be due to insufficient support for the test piece; fortunately it does not enable the machine to pass as correct pieces which are incorrect according to diameter of impression.

One of the firm's visual hardness testing machines of more advanced design is illustrated in Fig. 37. In this machine, by varying the loads and penetrators both the Vickers Pyramid test and the Brinell hardness test can be carried out on specimens ranging from thin sheet up to components 8in high by 10in diameter. This instrument has a built-in microscope which enables an enlarged image to be projected on to a ground glass screen, where measurements to 0·001mm can be made by an additional micrometer.

In this testing machine the loading microscope, projector, transformer and penetrator are carried in the top housing, which is supported on two pillars from the base casting, which houses the elevating screw and load release mechanism. Specimens are positioned on the table and raised to contact a spring clamp before focusing the surface of the specimen and applying the load. The action of clamping switches on the projector lamp illuminating the surface of the material.

Proportional weights, slotted for easy insertion on the platform suspended from the end of the loading lever, allow loads from 5kg to 120kg to be applied.

The load is applied by raising a hand-lever on the left-hand side of the base and the loading speed is controlled by an externally adjustable oil dashpot. The lever automatically moves upwards, when raised above 30 deg., under dashpot control; during this time the microscope and penetrator move backwards until the penetrator is in line with the optical centre of the microscope and the impression is made. When its movement ceases the lever is pulled forward to raise the weights. At the same time the penetrator moves forward to allow the impression on the specimen to be projected through the microscope objective.

The machine is provided with ball penetrators of 1mm and 2mm diameters, and a Vickers pyramid-shaped diamond indentor with a square base and an angle of 136 deg. between opposite faces.

Brayshaw Furnaces and Tools, Ltd.

A selection of standard industrial heat-treatment furnaces and engineers' small tools is shown by Brayshaw Furnaces and Tools, Ltd., of Belle Vue Works, Manchester, 12.

The five furnaces shown in operation include two oven furnaces, two high-speed

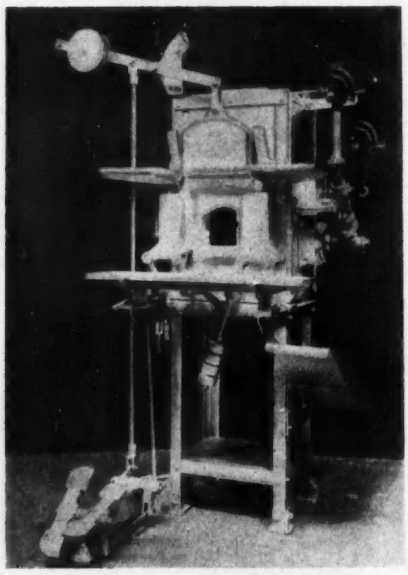


Fig. 38—Heat-Treatment Furnace—Brayshaw

steel hardening furnaces and an air recirculation vertical tempering unit. The largest of the two gas-heated twin-chambered furnaces for the heat-treatment of high-speed steel is illustrated in Fig. 38. It is designed for a maximum temperature of 1400 deg. Cent. and

is typical of the firm's latest standard range of impact heating furnaces. These furnaces have an improved burner arrangement which forms an easily removable unit, protection of the work from direct flame impingement, efficient damper control, and ample and conveniently placed work shelves, and tool rack for tongs, &c.

The upper chamber on these furnaces is used for preheating the work, and is maintained at a suitable temperature by the waste products of combustion from the lower high-temperature chamber.

An electrically-heated high-speed steel hardening furnace also shown in operation is designed for a maximum temperature of 1400 deg. Cent. It is heated by non-metallic "globar" elements with low-resistance metallised ends. The elements on this unit are mounted horizontally across the furnace and below the hearth to provide uniform temperature distribution.

The furnace is heavily insulated to reduce heat losses and hearth and baffle plates of silicon carbide afford rapid heating without risk of warping. Baffle plates are also incorporated along the side of the hearth to protect the work from the direct heat of the elements, and at the same time protect the elements from damage.

The furnace is fitted with an adjustable counterbalanced door lift incorporating an automatic switch, which cuts off the electric current when the door is raised.

Provision is also made for a gas "curtain" across the vestibule to prevent the entry of free air into the working chamber.

A vertical air recirculation furnace for tempering and low-temperature heat-treating is also exhibited. It is electrically heated, and designed for operation between 100 deg. and 750 deg. Cent. It comprises a work chamber formed of a cylindrical, refractory heat baffle, outside of which are located the elements. The work for treatment is contained in a basket.

A centrifugal fan in the bottom of the furnace recirculates the heated air at high velocity through the heating elements, and then downwards through the load. The whole of the heat is therefore convected to the load, the refractory heat baffle preventing any direct heat transfer by radiation or conduction from the heating elements.

The furnace is fitted with a cover arranged to swing clear of the top of the work chamber —a cut-out switch being fitted to interrupt the electricity supply to the furnace and recirculation fan as soon as the cover is raised.

Gear Grinding Company, Ltd.

Many points of interest are to be found in a new spur tooth grinding machine fitted with automatic cycle control, which has been developed by the Gear Grinding Company, Ltd., Shirley, Birmingham. This machine, like the other types of gear grinders made by the firm, uses a formed wheel and its automatic cycle reduces the work required from the operator to the simple loading and unloading of components and starting of the machine.

The new machine, with the splash guards removed, can be seen in Fig. 39. It is designed to grind gears up to 24in outside diameter with pitches from 2·5 to 16 D.P. Gears over 10in diameter are usually mounted on a mandrel projecting from the work head slide, which moves in vertical ways on the left-hand side of the machine. This slide can be fitted with a rigid bracket carrying a tailstock for accommodating work up to 10in long and 10in diameter between its centre and one replacing the mandrel.

The wheel head slide is hydraulically operated and moves on long ways on the rigid box section base of the machine. It has an infinitely variable stroke, which is long enough for grinding gears having face widths up to 8in. The wheel spindle is carried on bearings of special design and it is driven at some 1700 r.p.m. by a 2 h.p. motor mounted on the slide. The wheel head unit is carried on vertical ways and can be moved either by hand or power on these ways for wheel dressing purposes.

The feed of the work to the grinding wheel is effected by upwards movement of the work head slide through the automatic cycle control mechanism arranged below in the base of the machine. This automatic cycle control is operated by electrical means and through it a cam applies feeds at each

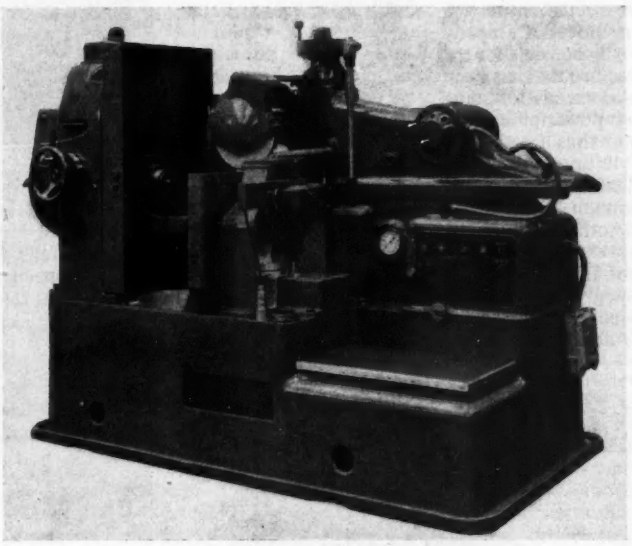


Fig. 39—Automatic Spur Tooth Grinding Machine—Gear Grinding

revolution of the gear being ground. The controlling cam plate is fixed in a horizontal position in the machine frame and its upper, stepped, face supports a ring member through rollers. The nut of the main adjusting screw for the slide is supported in turn by the ring member. At the end of each grinding cycle a ratchet built into the ring member is engaged by a pawl, which turns the member a set distance. This turning movement moves the ring up over one step on the horizontal cam face and gives an equivalent upwards movement to the work head slide which is then ready for the next grinding operation round the gear. For machine setting purposes the nut on the work head slide screw is turned by hand through a gear ring on the nut.

The number of wheel dressings and the stages during the gear grinding cycle at which they are carried out is predetermined by a strip pierced with holes and mounted round the periphery of the ring member in the control unit. Two bell levers in contact with the strip actuate micro-switches when they drop into the holes in the tape, as the ring member is indexed. The micro-switches initiate the wheel dressing sequence, after which normal grinding proceeds once again. Wheel dressing is carried out under pantograph control using three diamonds—one on each flank of the wheel and one on the periphery—as in the other designs of grinding machines made by the firm.

Other equipment on this firm's stand includes a 20in shaft grinding machine, a new design of "Orcutt" lead measuring machine, and an interesting display of Fellows gear shaper cutters which are now being made in this country.

Heenan and Froude, Ltd.

The many different types of high output production machines shown at Olympia include a group of the interesting wire and strip forming automatics made by Heenan and Froude, Ltd., Worcester. These machines are of precision design and construction and are built to work to close limits for long periods without skilled supervision or adjustment. In their various forms they are capable of producing an almost unlimited range of wire and strip parts from coiled stock in a single pass through the machine and the design permits many parts to be produced in pairs or fours. The makers state that small parts like electrical components can be produced at over 28,000 an hour.

In these machines the wire or strip is progressively bent round a central mandrel by a number of reciprocating forming slides (usually four), each slide being fitted with tools of the appropriate shape. A further slide feeds the machine regularly with a preset length of material which is straightened and cut off. After forming, the component is stripped off the central mandrel and ejected.

In the case of strip forming, a press ram is introduced between the feed slide and the central tool, and with this ram the strip can be pierced, blanked, lettered, &c., as required. In multi-stage tooling, which is sometimes used in the ram die set, the strip is only partly blanked at the first stage, and blanking and piercing is repeated in other stages as the strip progresses through the length of the die set in a follow-on sequence.

When the motions of the four forming slides are insufficient to produce the final shape, two-stage forming is introduced. In this, after the first motion of the slides, the partly formed product is moved a short distance down the centre tool and further operations are performed by a second set of forming tools mounted at a lower level on the same slides. Three-stage forming on similar lines can be occasionally applied.

Amongst the attachments available for special operations is a seaming unit for closing a joint in strip metal by means of a double lock seam or "can seam," transfer mechanisms, a ring setting attachment for sizing rings or ferrules accurately to shape, and twin wire feeds.

(To be continued)

Non-Destructive Methods for the Examinations of Welds. — The British Welding Research Association, 29, Park Crescent, London, W.1, has published a memorandum on *Non-Destructive Methods for the Examination of Welds* (price 5s.). It outlines the available methods—radiographic, magnetic, electrical, chemical, acoustical and penetrant methods. Emphasis is on the scope of application of each method, and the different examination techniques and the apparatus required are only briefly described. In short, the memorandum is intended as an introduction to the subject for the guidance of engineers and inspectors who may be unfamiliar with the advantages and limitations of the various methods.

A Gas Turbine Electric Experience

By EDWARD H. LIVESAY

No. 1

The Metrovick gas turbine-electric locomotive, the first such locomotive to be built in this country, has a maximum tractive effort of 60,000 lb and a continuous tractive effort of 30,000 lb. It is the most powerful express locomotive built in Britain. Mr. Livesay describes cab experiences with this locomotive drawing the 400 ton "Merchant Venturer" to Bristol and the 445 ton "The Bristolian" back to Paddington, light work for so powerful an engine.

ONE of the more interesting and unorthodox locomotives ever built in Great Britain began its trials a few months ago, and has since gone into service on regular trains — No. 18100, British Railways, the 3000 h.p. Metropolitan-Vickers gas turbine-electric express engine. Not only is it the first of the type to be constructed entirely in this country—the Brown, Boveri Company of Switzerland having been responsible for the other somewhat similar machine that has been running on Western Region metals for some time—but it is the most powerful express locomotive built in Britain thus far, having a tractive effort of 60,000 lb up to 14 m.p.h., which, it is expected, will enable it to handle 600-ton trains at a maximum speed of 90 m.p.h. For these and other reasons, I looked for a noteworthy experience when, thanks to the courtesy of British Railways Executive, I was recently given permission to travel upon this unique engine between Paddington and Bristol, and it is hardly necessary to say that my expectations were fully realised.

To anyone "brought up on steam," the prospective excursion was stimulating, and while *en route* from a distant suburb of London to the Willesden Depot at which the engine was stabled my attention was devoted to studying diagrams and data covering this unconventional locomotive. But, on arrival at the depot, I had less than enough time before No. 18100's burners were lit, the engine came to life and moved off towards Paddington. Inspector Wiltshire did his best to enlighten me in the limited period remaining, and I am accordingly obliged to him.

At this point a few particulars may be apropos as "refreshers"—the engine was described in detail in THE ENGINEER of February 1, 15 and 22, 1952. The engine, Fig. 1, is of the C_0–C_0 type, all six axles being driven by motors taking current from three generators connected through reduction gearing with a five-stage open-cycle gas turbine turning at a maximum of 7000 r.p.m.; there is no heat exchanger. The fifteen-stage axial-flow compressor is on the same shaft as the turbine, the combustion chamber, in which there are six parallel-axis flame tubes, lying between the two. Some of the chief dimensions are :—

Length over buffers	66ft 9in
Bogie wheelbase	15ft
Bogie centres	37ft 6in
Wheelbase	53ft
Width of body	9ft
Height above rail	12ft 6in
Weight	130 tons
Maximum tractive effort	60,000 lb
Continuous tractive effort	30,000 lb

Air braking is fitted on the engine, with vacuum gear for the train. When the driver applies the brake, the engine air brake automatically goes on in the correct ratio unless the dual action is prevented by the pressing of a trigger on the brake handle. Hoffmann roller bearings are fitted, with leaf springs above and below each box, which does away with hangers. The Brown Boveri engine has helical springs which, I was told, gave somewhat better riding. Four electric spot-lights are provided, and a two-note horn, at both ends, the engine being double-ended with identical cabs.

Fig. 1—Gas Turbine Locomotive No. 18,100

Fig. 2 shows the interior of a cab, with its two seats, which are the most comfortable I have seen on any British locomotive. This arrangement is possible because the engine-men do not have to get out of the seats for anything under normal conditions, all the controls being arranged on and above a desk in front of them, extending right across the cab. The main controller, the equivalent of the regulator of a steam locomotive, is immediately in front of the right-hand (driver's) seat, No. 18100 having "right-hand drive," thus favouring Western Region peculiarities. It moves over the segment of a circle marked in degrees from zero to 110. Under the right side window will be seen the vacuum brake handle; the two small handles to the left of the controller concern forward and reverse motion, and the key switch energising all the cab controls, which shows a red light when switched on. These two handles interact, and unless both are in the right position, the main controller cannot be moved. Under the desk, in the middle of the cab, is the engine air brake handle, placed in this somewhat out-of-the-way position with the idea of having a clean cab, and bearing in mind that it is seldom required, the driver depending chiefly on the vacuum apparatus because of its association with the A.T.C. used on the Western Region.

In front of the driver's position will be seen four dials; reading from left to right they are air brake pressure, ammeter, speed indicator and train pipe vacuum. Beside the latter is the horn trigger. The left (fireman's) side dials, also reading from left to right are steam heat pressure, auxiliary supply voltage—battery and auxiliary generator, turbine revolutions, water supply (600 gallons), fuel supply (960 gallons), engine air brake, with two needles, there being two hoses to the brake cylinders for safety reasons; they should register alike, if both hoses are in good condition. The hand brake is prominent in front of the fireman's seat. Underneath the dials are numerous push buttons connected with lights, &c., and in the middle, others governing window-wipers, and so forth. Immediately to the left of the left-hand dials is the tell-tale light that shows green when the turbine reaches idling speed, 4500 r.p.m., at which it is safe to move the engine; it is immediately above the red light already referred to.

There is no dead-man's handle or pedal, though one could be fitted without difficulty if called for, but with two men in the cab it is not necessary. While the driver's chief preoccupation is the main controller as a gauge to power output, the ammeter is, of course, a partial guide; it should read about 300 at starting the engine "light," and should never go higher than 1100, the equivalent of 60,000 lb tractive effort.

Controls and gauges connected with the steam-heating boiler, which is in a compartment immediately behind one of the cabs (the one nearest the exhaust end), are arranged for the fireman's attention. In summer time he is more ornamental than useful, except as additional look-out. The same thing applies to a fireman on a diesel-electric, as was mentioned in the articles on the Esquimalt and Nanaimo engines. Drivers in North America very often show a tendency towards *embonpoint*; it looks as though firemen in Britain will follow the fashion should gas-turbine and diesel locomotives become popular over here!

The "starting-up" procedure naturally interested me—the lighting of the burners; bringing the turbine and compressor into motion, and so on. Watching the operation from beside the gauge-panel near the turbine, the sequence of events given me by one of the Metro-Vick assistants was as follows. First, the boost pump takes oil from the tank under the frame, delivering it at 15 lb to the main fuel and pump set, which consists of main fuel and lubricating oil pumps on one shaft—incidentally there are two of these sets, to guard against failure, though only one is in action at a time. Three pressure switches then close and the starting drum begins to turn at a controlled speed, its contacts energising (1) the igniter boost coils connected to the ignition plugs; (2) turning on fuel to the igniters through the idling jets; (3) switching on current from the generators, which are used as starting motors. When the turbine reaches 1000 r.p.m., the isolating valve opens. Combustion assisting, and turbine speed having reached 2500 r.p.m., the drum switches off the battery and the turbine accelerates

under its own power to 4000 r.p.m. Ten seconds elapse from the time the starting button is pressed until the turbine begins to turn; the battery is disconnected in twenty-five seconds, and idling speed reached in a further twenty-five seconds. Full power may be called upon after ten minutes idling or low power operation.

Primary ignition takes place in two flame tubes, the ignition spreading subsequently to the other four through tubular connections; the ignition can be observed through a window in the flame tubes concerned with the primary stage. The fuel, it may be stated, has a specific gravity of 0·85. The roar of the exhaust is in no way objectionable, in some degree no doubt because it is continuous, not intermittent, and is certainly not nearly so obtrusive as the staccato beats of a steam locomotive with quick port openings.

Fig. 2—Driver's Cab

In due course No. 18100 moved away towards Paddington, with Driver Hinder at the controller, Driver Pither standing by—at the other end—and Fireman Keble also standing by in the same location, his sole care, the train-heating plant, being out of commission in summer. For the first time I experienced the motion of a gas-turbine locomotive; it was pacific and quite free from vibration of any kind; there was no noise worth mentioning in the cab—there are two doors between cab and engine-room—and from outside came nothing but the occasional note of the two-tone horn. Arriving at Paddington, coupling-up was done very gently; evidently there is no difficulty in handling a gas-turbine locomotive with electrical transmission. The train was "The Merchant Venturer," and the load 400 tons as far as Reading, where one coach was to be slipped. Apparently the ex-G.W.R. still uses slip-coaches, in which it is an exception among British railways, I believe; one wonders why this apparently useful arrangement has gone so much out of favour.

The train left Paddington punctually at 11.15 a.m., in fine but dull weather, the turbine making 6000 r.p.m. Acceleration was steady, nothing spectacular, made no doubt without slipping, which is not likely to occur on dry rails, where 130 tons are available for adhesion. It was deceptive, however, and quicker than one realised, though not so deceptive as it had been on the 4000h.p. twin-unit Chicago and N.W.R. diesel-electric—the "400," my first experience of an engine of that type a decade ago: when the driver—"engineer," I should say—asked me what my estimate of the speed was, I hazarded 45 m.p.h., to have my attention directed to the speed-recorder, which registered 65. Though not so badly in error on No. 18100's rate of progress, nevertheless, I consistently underestimated it until later in the day, when I had become used to the engine. At Old Oak Box, 2½ miles from the start, it was 40—at Acton 45—W. Ealing 50, at which the revolutions were 7000. Let it be stated here and now that most figures of speeds, revolutions, distances, &c., are close approximations only, but near enough to actuality for practical purposes, the chief of which is to give a general impression of what No. 18100 did and how it was done. Meticulous timing and measuring and preoccupation with split-seconds and mileposts are to me all alike anathema; they strike me as nothing but the adult equivalent of a youthful "spotter" with a note-book, all the more so as post-war speeds on British Railways are so seldom worth recording. If I were to travel on a locomotive engaged in an important test run, then my attitude to minutiæ would doubtless be different, but in the present case, where an ordinary train was running over a well-known road at quite ordinary speed, with a load nothing out of the way either, all such punctilio is superfluous, mere padding, and I am convinced most readers would consider it to be such. All speeds *en route* were readings from the recorder in front of the driver, called across the cab by him, or the inspector, when asked for, and duly entered in the log.

At Hayes, 11 miles from the start, 60 m.p.h.* was reached for the first time, and here the transition from bull-head to flat-bottom rails was noticed, the difference in sound and reaction being evident. The same thing was recorded several times during the day, and the unanimous opinion of everyone appealed to for a ruling was that the f.b. rail was the better of the two. Joints were less perceptible and running smoother, the deeper section of the f.b. rail being advanced as the deciding factor. The new rails are of the standard 60ft length.

Only the usual two-man crew is visualised in the future, when teething troubles have been overcome and the enginemen acclimatised. No more than two should be necessary, any more than on a jet plane, both plane and locomotive being expected to perform without expert supervision under service conditions. If this counsel of perfection proves to be attainable, No. 18100 will score over the twin-unit, 4000 h.p. diesel I rode between Chicago and Milwaukee, on which there was a "maintainer," an expert to whom alone the intricacies of the forty-eight cylinders, four generators, eight traction motors and their appurtenances had no mysteries and their care could safely be entrusted—the so-called "engineer" did not know the front of the engine from the back and admitted it. His not to question why, his but to do and drive, like the average car-owner in the States, who goes to a garage when a plug needs changing. This is a good illustration of twisted American railroad terminology, which seldom calls a spade a spade—it is more apt to be a "real-

* Toward the end of the day I was advised that speed-indicator readings were below recordings, so all figures given should be slightly increased.—E.H.L.

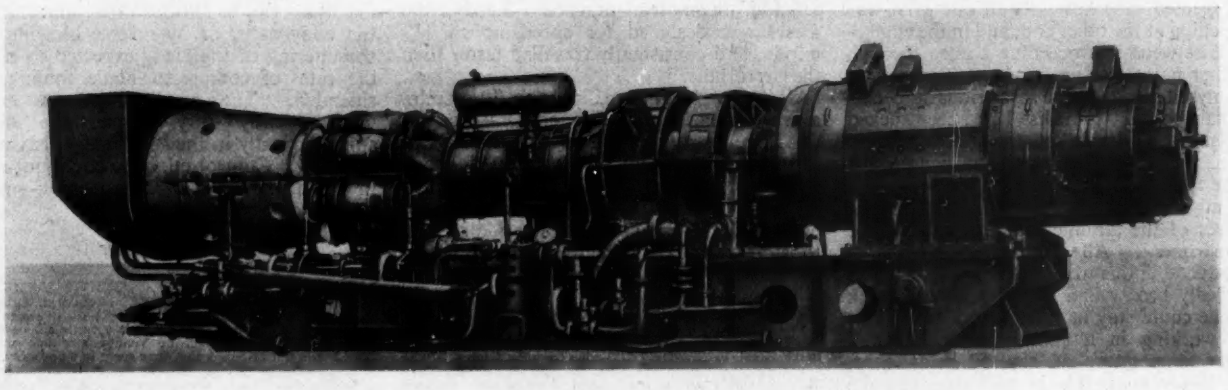


Fig. 3—Gas Turbine Power Unit

estate remover." This, of course, clarifies everything, and makes a misunderstanding impossible.

The speed at Iver was 65 m.p.h.; at Dolphin Box, approaching Slough, it was borne in upon me that some, at any rate, of the nosing I had been pondering over was due to the track, because it was accentuated here by re-laying, done recently. Shortly after, we were checked by signals to 40 m.p.h., and had only just regained the normal 60/70 m.p.h. near Twyford, passed at 11.45 a.m., when we were again brought to 40 m.p.h., by a restriction due to a slip in the side of a cutting, leading to the collapse of the retaining wall and temporary relocation of the track. A couple of miles farther on, in Sonning cutting, a similar slip had taken place; here the restriction was 30 m.p.h. Both slips were curious, as the cuttings were not deep, nor lying at an acute angle; possibly subsurface springs under clay were responsible.

Reading was passed at 50 m.p.h., and a coach slipped, reducing the load to 365 tons, nothing to concern an engine with a tractive force of 60,000 lb working over the Paddington–Bristol route; throughout the entire 118 miles there is not a single adverse gradient worth consideration.

The indicator showed 65 m.p.h., passing Tilehurst, and 70 m.p.h., at Pangbourne, a little farther along, on what passes for an acclivity on this line—1 in 1320. I find a reference on my pad here to nosing, to the effect it was about the same in degree as that of the Esquimalt and Nanaimo Railway diesel-electrics, B_0–B_0, described in THE ENGINEER a couple of years ago. I would like to remove any misconception by saying I am not complaining about it, merely stating it was more evident than I had expected to find it. If it had been like the nosing experienced on the leading motor-coach of an electric train out of Victoria that very same evening, when I was returning to Croydon after this gas turbine run, then there would have been real grounds for complaint. There can be no objection to a reference being made to this bad riding of some motor-coaches, as I remember a paper being read before, I think, the Institution of Locomotive Engineers some time ago that went into it thoroughly, which resulted in an interesting discussion; both were given room in THE ENGINEER. In passing, vertical movement of No. 18100's floor was little in evidence, so the springing system is satisfactory enough.

Didcot was passed at 75 m.p.h., turbine speed 7000 r.p.m.; time 12.15 p.m., 1 h from Paddington, 53½ miles, the speed so far having been mediocre, due partly to restrictions and partly to the lack of necessity for anything higher, in view of the schedule. We were running on really good track now, I was told, and would continue to do so to the finish, so my surmise that all had not been too well with it farther back was substantiated.

It seemed time now to find out what was happening at the other end, and in the engine-room between; proceeding thence through the first narrow alleyway, I was annoyed to find myself held by some mysterious influence, and said so, only to realise I had been sucked up against the grille of the motor blower.

Apart from faint turbine and compressor whine the only sound in the engine-room was of a mighty rushing wind coming through the louvres of the air filters in the walls of the compartment. All air for combustion is introduced in this way, so the engine-room is decidedly breezy and cool; I do not think anyone could stay in it for long if the engine was working in a country cursed with a winter temperature of, say, 50 below zero, it is barely endurable in still air, and quite unbearable in a wind. However, No. 18100 was not designed to work in the Arctic regions, and no doubt suitable alterations could be made to the air inlet arrangements if necessary; I merely thought of all this when passing through the engine-room.

In the rear cab oscillation was somewhat greater than in the front one, which must result from the similar action of the first coach multiplying that of the engine. Perhaps jaw-couplings might reduce both. I do not want to give a wrong impression by referring to nosing again; the matter may be that, where locomotive riding is concerned, I have always had a certain standard of excellence to use as a datum line, as it were—the twin-unit diesel-electric engine on the Chicago N.W. Railway, which I described in THE ENGINEER a decade or so ago, and have harked back to once or twice since. That, without exaggeration, can be taken as the very last word in perfection when riding is under discussion, and I have always thought of it as such since. The article describing it is not at hand for reference, but I think it included the statement that a Rolls-Royce car running over a perfect road could have travelled no more smoothly (I admit never having ridden in a Rolls-Royce car over such a road, but my sensory imagination is in good working order). There was no feeling of wheels on rails whatever; the engine did not roll along them—it glided. There was neither vertical nor horizontal movement, no vibration, no nosing; curvature was entered without any shock. It was the poetry of locomotion on rails—the last word. I do not think this description is in any way exaggerated; that was how the 4000 h.p. machine behaved as it swept along beside the blue waters of Lake Michigan at 110 m.p.h. With that as the standard I had rather expected No. 18100 to behave in the same way, and was a trifle disappointed to find it did not. Thinking about the dissimilarity in the action of the two engines since, I may have hit on a reasonable explanation. It does not lie in the track; even post-war British permanent way is at least as good as that of the C. and N.W.R. after ten years of "depression." It probably results from the limitations imposed on the designers of No. 18100's trucks by the fact that all three of the axles are motored, whereas on the diesel only the two outer ones are; the middle axles are lower in the frames, with smaller wheels than the drivers, and there is no motor to get in the way of control and suspension arrangements for which there is no room on the gas turbine engine. In addition, the bogie pivot of the latter is close to the middle axle and its attached motor, adding to the congestion there. In short, the springing and suspension of the two engines are different, space limitations to some extent dictating the design of No. 18100's trucks; the deciding factor that so often vitiates comparisons between British and Trans-atlantic locomotive practice. Lastly, the diesel was designed for speed up to 117 m.p.h., and consistently travelled faster than the gas turbine.

Swindon, 12.35 p.m., passing 70 m.p.h., average from Paddington 56 m.p.h.—was not this done nearly a century ago in the days of Sir Daniel Gooch and his 8ft singles?† When shall we again see fast travelling on British metals? I am beginning to wonder if we ever shall. Everyone at the lineside seemed to stop work to see the unusual locomotive go through—it was also the dinner-hour. Down the Dauntsey bank a few miles farther on it was held well in hand, and afterwards, also, to avoid getting too much ahead of schedule. Rain began at Chippenham, the window-wipers taking up their rhythmic sweep across the windows. If considered necessary on diesel and turbine locomotives, why are they not equally so on steam engines? In fact, they are more necessary, the small windows, smoke, steam and dirt of the latter often making the look-ahead bad in any weather, and next to impossible in wet. Why should the driver of a steam locomotive be expected to work his engine with his head out of the side window, in the slip-stream, while his diesel or gas turbine brother sits in comfort behind a clear glass? It is an anachronistic state of things, at any rate, on express locomotives.

At Chippenham the Brown-Boveri gas turbine engine passed going "up"; greetings were exchanged on the horns. Shortly after came the 2¼-mile Box tunnel; like Dauntsey, it is 1 in 100 down, and was traversed in 1.47, the "Merchant Venturer" coming to a stand in Bath at 1.05 p.m., which gives an average of 58·4 m.p.h. from Paddington. Station time occupied 7 min here, due to a short platform making double stopping necessary; in addition, it is built on a curve, which masks the guard's green flag, and a colour-light starting signal marked "R.A." (right away) is provided. The final restart was at 1.12 p.m. It is very lovely country here, lush and green, with the Avon meandering alongside; Western Region might consider calling a train "The Pickwickian." The outlook had been pleasant right along, once London's tentacles had been left behind, and I was almost sorry when the train came to a stand in Temple Meads Station, Bristol, at 1.27 p.m., 118 miles, 2 h 12 min average from London, 53·6 m.p.h. inclusive. Nothing exactly epoch-making about that,‡ but no fault of the engine, which had played with the job throughout. It proceeded to the yard for refuelling and so on, with ample time available, "The Bristolian" not being timed away for the return trip until 4.15 p.m.

No. 18100's crew, attendants and observers, both B.R. and Metro-Vick, adjourned *en masse* to the canteen, where an excellent and satisfying lunch was disposed of in an atmosphere of good fellowship and fish and chips. Conversation covered a wide field, including the theory and practice of gas turbine locomotives, and the inordinate wages paid Canadian railwaymen.

During this interval, besides re-fuelling, one or two manœuvres were carried out, such as going to Mallago to pick up the train, and I again watched the lighting-up process, noting the short time necessary before the engine was ready for work, and the spotless cleanliness of the turbine compartment, largely due to the filtering of all air coming into it through the louvres. The dry filters can be cleaned after removal from the body-walls, or by reverse blowing, and the filtering of the air is expected to reduce the rate of compressor-blade fouling considerably. The handling of the engine was evidently very simple, the driver, still practically in the "L" stage, having no difficulty. Control mistakes could not result in anything very serious happening—mostly in nothing happening at all.

(To be continued)

† From a G.W.R. publication of 1936: "Trains hauled by these engines—the broad-gauge 8ft singles—were booked in the time-table to leave Didcot, 53 miles from Paddington, 57 min after their departure from London, and repeatedly did the run in 50 min, and often in less. And that in the 'eighteen-forties,' mark you!" Apparently the speed hasn't been much improved in over a century. Our time to Didcot was 60 min.

‡ From the same publication: "The London to Bristol trip was actually covered by one of these engines with a load of 100 tons in 2 h 12 min, inclusive of 9½ min spent in stoppages." It happens that "The Merchant Venturer's" time was also 2 h 12 min, but as only 7 min were spent in stoppages Gooch's 8ft single beat us on points. *Mirabile dictu!* Fanatics, don't refer to the respective loads; the tractive effort of the 8ft singles was 9640 lb; No. 18100's was 60,000 lb. "Lord of the Isles" still wears the laurels.

The Trostre Tinplate Works

No. II—(*Continued from page 414, September 26th*)

An important part of the reconstruction project for the South Wales sheet, steel, and tinplate industry is the tinplate plant of the Steel Company of Wales, Ltd., at Trostre, near Llanelly. This plant is now in production and will eventually receive some 7000 tons of hot-rolled coil a week from the Abbey Works for processing into 140,000 boxes of tinplate a week.

Electrical Equipment of Pickle Line

As described in last week's article, cold rolling is done in the Trostre works, where strip received from the continuous hot strip mill at Margam is first passed through the pickle line to remove scale and other impurities from the surface. The pickle line handles strip up to 38in wide and gauges up to 0·093in at speeds up to 650ft per minute. It consists of three sections. In the first or entry section the strip passes in turn through the uncoiler, processer, upcut shear, stitcher and stitcher pinch rolls. The second section comprises the entry pinch rolls, acid and water tanks, the dryer table and the follower pinch rolls. The last section embodies the upcut shear, side trimmer and coiler. For the main drive the General Electric Company, Ltd., supplied seven totally enclosed fan-cooled a.c. motors, six of which are rated 0/97·5/97·5 h.p., 0/1100/1560 r.p.m. The processer motor is a 0/455/455 h.p., 0/850/1300 r.p.m. forced ventilated motor. There is also a 65/65kW, 670/1280 r.p.m. forced ventilated mandrel drag generator with its booster and cascade exciter set. Power for the driving motors is derived from a six-machine motor-generator set, comprising a 1250 h.p., 11kV, 1000 r.p.m. synchronous motor driving three generators and two exciters. Each of the three sections of the pickle line is controlled from desks and control cabinets conveniently placed along the line. The correct tension between the mandrel and processer is maintained by cascade exciter control. As the strip passes through the pickling tanks its level is regulated to prevent its dragging on the bottom or breakage of stitching through excessive tension.

Cold Reduction Mill

From the storage area at the end of the pickling line the coils, weighing up to 30,000 lb, are transferred to a five-stand tandem cold reduction mill, which is designed to run at a maximum speed of 4500ft per minute. This mill has work rolls 21in diameter by 48in long, with 53in diameter, 47in long back-up rolls. Its work rolls are carried in tapered roller bearings and the back-up rolls in "Margoil" bearings. The main units of the mill lubrication system are arranged in a cellar immediately below the mill. During rolling, a mixture of palm oil and water is sprayed on to the strip and the rolls are cooled by means of water sprays.

At the entry side of the mill the coils are set in the coil rotating ring and coil box to be seen in Fig. 5, and the leading edge is hand fed between the work rolls of the first stand at threading speed. The strip is fed to each stand in succession, a heavy tension being applied to the strip between the stands. On emerging from the final stand the leading edge of the coil is guided on to the exit reel and a belt wrapper is used to form the first few turns. The belt wrapper is then withdrawn and the mill is accelerated to the desired running speed.

The vapour produced by the cooling water during rolling is exhausted into a fog elimination system and discharged through a chimney to the atmosphere. The palm oil and water flowing off the sheets is conveyed to a recovery system, where the oil is separated from the water and passed through a reclamation unit for re-use in the mill.

The photograph reproduced in Fig. 6 shows the exit end of the mill and the strip being reeled as it comes out of the final stand. Coils are ejected sideways off the reel on to a ramp. As each coil passes down this ramp it is automatically weighed before passing to the stock lines ready for the next process.

Electric Drive

To accommodate a variety of rolling schedules the relative speeds of the stand motors must be adjustable over a considerable range. When the stand speed relationship has been set it must be maintained within fine limits by the electrical equipment under widely varying conditions of mill speed and load. At the same time a reasonable tension must be kept in the strip between the stands. In addition, acceleration and retardation should be as rapid as possible, because the strip tends to run "off gauge" at low speeds if the mill is set to roll correct gauge at its nominal speed.

The reel at the end of the mill and the five-mill stands are driven individually. Each stand motor drives the bottom work roll directly and the top work roll through the pinion stand. There is a direct drive from the reel motor to the mandrel. In the view of the motor room (Fig. 7) the mill motors and the reel motor can be seen in the background, with the wall which separates the motor room from the mill room.

To meet the speed requirements outlined above, multi-armature, direct-current motors are used, the speed of the mill being controlled by armature voltage and the relative speeds of the stands being adjusted by a combination of armature voltage and field control. Each stand motor is supplied from its own generator or group of generators—with one generator for each armature. In this arrangement the individual stand circuit is self-contained, whereas, in the earlier common busbar system a number of generators were connected in parallel to a busbar supplying all the motors.

The stand and reel motors are British Thomson-Houston "M.P.C." compensated compound wound machines with commutating poles and off-set pole face windings to give extra stability.

The machines (Table I) are capable of running at 1·25 times full load for two hours and withstanding frequent working peaks of twice full load with a cut-out peak of 2·4 times full load. Because the accelerating currents and differences in referred inertia between stands must be kept as low as practicable, multi-armature motors are employed and each armature has a greater ratio of core length to core diameter than is usual on conventional d.c. motors. The stand motors have low inertia drum-construction armature spiders while the reel motor, which has a relatively small armature diameter, has the four armature keys welded directly on to the shaft. These machines rank among motors having the largest ratio of armature core length to core diameter driving rolling mills to-day.

Table I—*Summary of Electric Drive*

	Motors				Generators			
Stand	No. of Armatures	Total h.p.	Motor r.p.m.	Mill Speed, f.p.m.	No. of Generators	Total kW	Generator Voltage	M.G. Set No.
1	1	1750	90/230	495/1260	1	1600	600	1
2	2	3500	125/273	688/1500	2	3200	600	1
3	2	3500	200/400	1100/2200	2	3200	600	1
4	2	4000	350/582	1925/3200	2	3200	600	2
5	3	5500	500/818	2750/4500	3	4800	600	2
Reel	2	900	210/900	—	1	720	600	1

Synchronous Motors.—Each M.G. set is driven by an 11,580 h.p., 11,000V, 750 r.p.m., unity power factor, three-phase, 50-cycle synchronous motor.

Direct driven overhung tacho-generators mounted on the non-driving end pedestals provide speed indication and supply overspeed protection relays.

The multi-armature arrangement of the stand motors requires between 1750 h.p. and 2000 h.p. per armature. Identical B.T.H. 1600kW, 600V generators supply each stand motor armature. A single 720kW, 600V generator supplies the two reel motor armatures. The generators are divided between two motor-generator sets, the six generators for stands 1, 2, 3 and the reel being on one set and the five generators for stands 4 and 5 on the other.

Each of the motor generator sets is driven by a B.T.H. 11,580 h.p., 11kV, three-phase synchronous motor. Normally it is reactor

Fig. 5—Entry End of Cold Reduction Mill

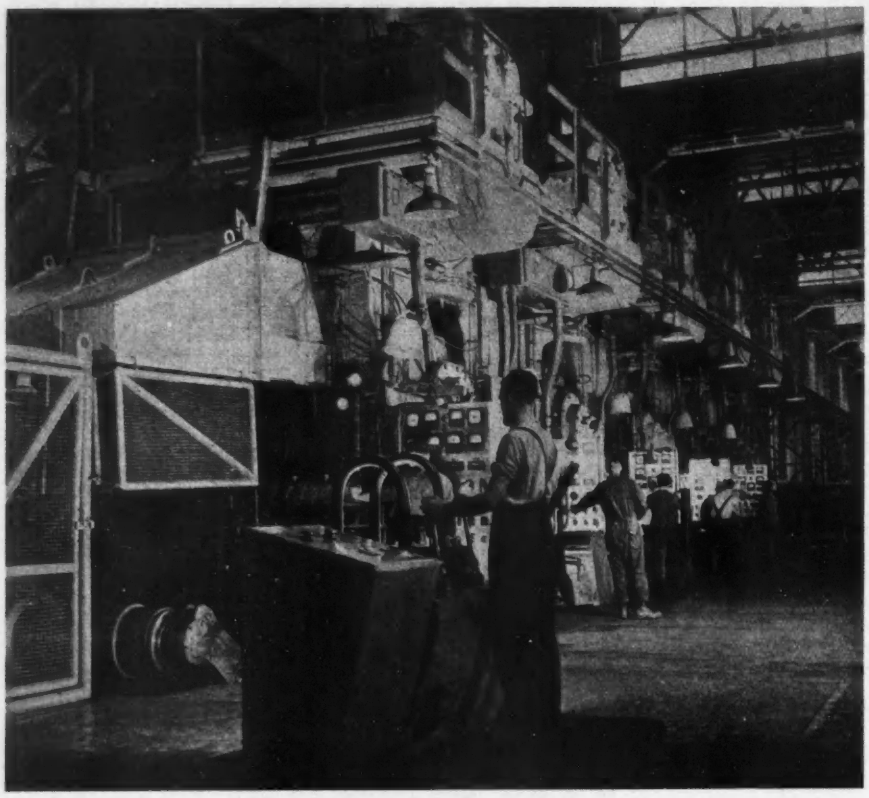


Fig. 6—5-Stand Cold Reduction Mill

started but it is suitable for direct-on-line starting in an emergency. After closure of the line circuit breaker starting of the motor generator sets is completely automatic. "Amplidyne" control of the synchronous motor excitation is used to maintain either constant power factor or constant reactive kVA after the motor has been synchronised. The motor generator sets and the auxiliary exciter sets for control supplies, for synchronous motor excitation and for stand and reel control are installed in the motor-room (Fig. 7). This room also houses four B.T.H. pumpless steel tank mercury arc rectifiers, each of 300kW capacity at 230V, for general workshop supply.

A separate 10MVA, 33/11kV transformer feeds each of the tandem mill motor-generator sets. There is a 3·3kV supply for the two 300 h.p. exciter set driving motors. The smaller exciter set motors and the various auxiliary circuits are supplied at 415V.

The Control System

All the armatures of the multi-armature motors are connected in series, which ensures load sharing between them as they all carry the same current. Alternate series connection is used, i.e. motor—generator—motor—generator, so that the voltage across any part of the circuit does not exceed that required by one armature even under fault conditions.

Mill Speed Control.—The speed of the whole mill is raised by increasing the voltage of all the generators in unison. To do this all generator fields are first excited from a single generator exciter GFE, Fig. 8. This arrangement enables all the generator voltages to be raised together but does not give the required accuracy of correspondence.

A mill reference voltage is set up by a master pilot exciter, MPE. The fields of exciters GFE and MPE, and hence their voltages, are controlled through dials D 1–4 and D 2–4 on a master rheostat. The master pilot exciter supplies the stand reference voltage dials D 1–2 of the stand speed rheostats SSRH so that all the stand reference voltages vary with the master pilot exciter voltage. The individual stand generator voltage is controlled by a B.T.H. "Amplidyne" regulating exciter, RE, which is connected in series with the generator field. The stand reference voltage is compared with the generator voltage through a field F1 on the regulator RE. Any difference between these two values, therefore, excites RE to correct the generator voltage to correspond to the stand reference voltage. Only a slight voltage across the field F1 of RE is necessary to excite RE and provide the correction voltage. The field F2 on RE is differentially connected across its armature to accelerate the response of RE to field changes and to reduce residual.

Master Rheostat.—The voltage of exciter MPE and hence the speed of the mill is determined by the position of the master rheostat arm. This arm is driven by a motor supplied from an "Amplidyne," which acts as a position control regulator of the rheostat arm at threading speeds and as a direct closed-loop regulator of the mill speed at running speeds. The rheostats which pre-set the "thread" and "run" speeds are mounted on one of the mill cabinets, and momentary depression of push-buttons on the delivery side cabinets initiates "thread," "hold," "run" and "stop."

Constant acceleration and retardation of the mill are achieved by limiting the "Amplidyne" voltage to a pre-set value; the acceleration rate is adjusted by means of a rheostat on a mill cabinet.

Stand Speed Relationship.—On any individual stand generator the voltage can be varied by modifying the reference voltage through the stand speed rheostat SSRH and dial D 1–2. Similarly the stand motor field current is varied by another dial D 2–2 on the stand speed rheostat. The two dials are graded so that the field weakening speed range starts immediately after full generator voltage has been reached. Coarse speed control is derived from the stand speed rheostats, which are motor-operated and controlled by switches on the cabinets. Fine control of the motor speeds is obtained by small hand-operated rheostats, connected in series with the motor exciter MFE field circuit. On stand 5, however, the complete speed range is covered by a single rheostat with a large number of steps; it is operated by a servo-selsyn system from a large hand-wheel on stand 5 delivery side cabinet.

Load Compensation.—Because of the armature resistance, the speed of each motor varies with its load current and this variation is an appreciable proportion of the speed at reduced voltages. Load compensation is introduced to maintain the stand speed relationship with varying load current by increasing the stand generator voltage by an amount dependent on the armature ohmic drop. An "Amplidyne," OD, is connected in the stand reference circuit and its field, F 1, is excited from across the generator compole and compensating windings. The armature voltage of "Amplidyne," OD, which is proportional to load current, increases the stand reference voltage and therefore causes the stand generator voltage to rise by the same amount. The extent of compensation is controlled by the mill operators on rheostats SLC mounted on the cabinets.

Tapered Tension.—The quantity of "off gauge" strip produced at threading speeds and during acceleration and retardation can be reduced by increasing the interstand tensions at low speeds. This result is achieved by using stand 3 as a pivot and progressively increasing the voltages of stands 4 and 5 generators while

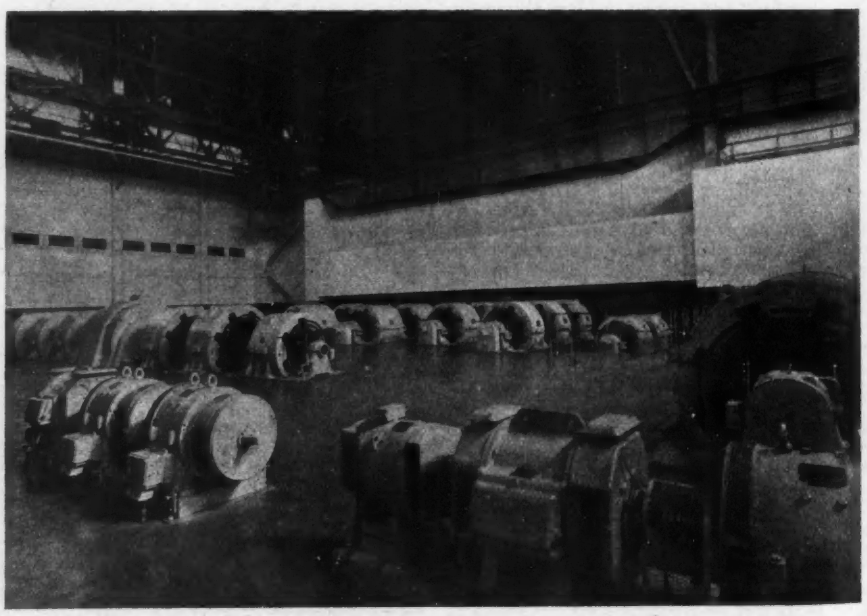


Fig. 7—Motor Room

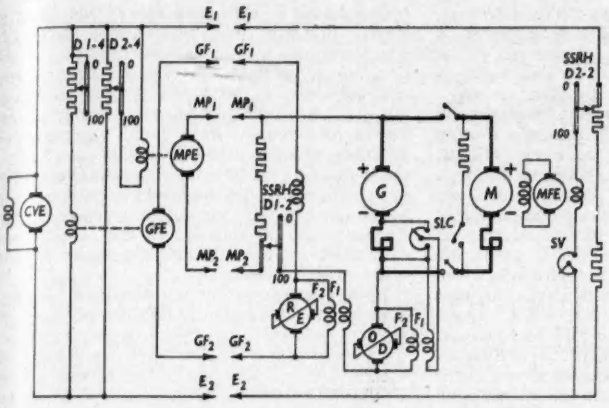


Fig. 8—Mill Excitation and Stand 1 Diagram

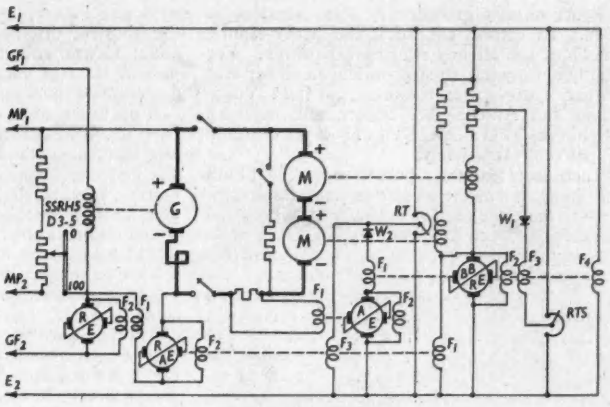


Fig. 9—Tension Reel Diagram

decreasing the voltages of stands 1 and 2 generators as the mill approaches low speed. These additional voltages are reduced to zero as the mill speed rises towards the normal " on gauge " speed. A field winding on each " Amplidyne," OD, supplied from the master rheostat, produces the extra stand generator voltage in the correct direction, and the value of the voltages can be adjusted by rheostats on the mill cabinets.

Inching.—Each stand and the reel can be inched by switches on the control cabinets, which produce a small voltage at the generator by exciting a field of the regulating exciter RE.

Tension Reel Control.—A definite tension must be kept in the strip between stand 5 and the reel to produce a satisfactory coil build-up and to help maintain a constant gauge. With a constant strip speed, the reel motor must reduce speed as the coil diameter increases. Its speed range by field control must cover the build-up of the coil from the 20in diameter of the mandrel to a maximum of about 72in outside diameter.

The horsepower required to produce the tension in the strip is equal to the horsepower output of the reel motor, neglecting the small losses in reel friction and windage.

Let T=Strip tension (lb)
S=Strip speed (feet per minute)
k=Reel motor efficiency
V=Reel motor armature voltage
I=Reel motor armature current (amp.)

Then $\frac{TS}{33{,}000}=\frac{kVI}{746}$

Thus T is proportional to $\frac{V}{S}\times I$

T is therefore held approximately constant by making both $\frac{V}{S}$ and I constants. The accuracy of tension control by this means is adequate for all except very light tensions which are not required in this instance.

Volts/Strip Speed Control.—The strip speed from stand 5 depends on the mill reference voltage and on stand 5 speed rheostat setting. The reel reference voltage is obtained by modifying the master pilot voltage by means of a further dial, D 3–5, on stand 5 speed rheostat, so that the resultant voltage is proportional to stand 5 delivery speed. This voltage is applied to a generator regulating system (see Fig. 9) similar to that described previously which controls the reel generator voltage to correspond to the reel reference voltage.

Constant Current Control.—The reel motor fields are supplied from a constant voltage source in series with a buck-boost regulating " Amplidyne," BBRE. A field, F 1, on BBRE is connected in a comparison circuit through a rectifier, W 2. The reference value of current to be controlled is set by a rheostat, RT, supplied from the constant voltage source. The actual current is measured by the voltage across a resistance in series with the reel motor armatures. This voltage is, of course, quite small and is therefore amplified by an " Amplidyne," AE. When the output voltage of AE is greater than the setting of RT, it sets up current through W 2 and excites field F 1 of BBRE. This current strengthens the reel motor fields, which in turn tend to slow down the reel to the speed required to give the set current. Balance is reached when the motor current ceases to rise and just sufficient current flows through field F 1 to give BBRE the required excitation.

Speed Limit and Reel Threading Speed.—A field, F 4, on BBRE permanently biases the latter in a direction to weaken the reel motor fields but to give a definite minimum weakfield in the reel motor a limit circuit is employed using field F 3 on BBRE and rectifier W 1. A rheostat, RTS, is connected in this circuit while threading to give the operators control of the reel motor speed for correct wrapping of the first few turns on the mandrel.

Stalled Tension.—A field, F 1, of the reel auxiliary " Amplidyne," RAE, is connected across the armature of BBRE to cause RAE to produce a small voltage at the reel generator, which is sufficient to maintain a light tension in the strip at standstill.

Other Compensation Arrangements.—The ohmic drop in the reel motor circuit is neutralised by RAE, which is excited by a field, F 3, connected across the tension setting rheostat RT. The reel generator voltage is thus increased by an amount depending on the current that is regulated.

During acceleration and retardation, part of the reel motor armature current is required to overcome the inertia of the rotating parts. A compensating quantity is fed into a field of " Amplidyne," AE to modify the current reference and permit the correct current to flow in the reel motor to maintain tension.

Each regulating system is stabilised to prevent hunting and to give good transient response by the introduction of transformer feed-back from suitable parts of the circuits into " Amplidyne " fields. For simplicity, however, these feedback circuits are omitted from the diagrams (Figs. 8 and 9).

Cooling

Cooling air for the mill motors and generators is provided by a closed circuit system. Individual fans on each armature distribute the cool air, which is drawn from a plenum in the basement. The air enters each machine at the driving end, leaves at the commutator end, and returns through coolers to the basement. Before being discharged through the coolers the warm air from the mill motors is delivered into a common ducting. Each generator has its own cooler. The synchronous motors are self-ventilated by their rotor fans, which take air from the basement and return it through individual coolers. To allow access to the brushgear and to prevent commutator dust from fouling the recirculating air the commutators of all machines are open to the motor-room. The small quantity of air lost through the commutator seals is replaced by a separate make-up fan, which supplies clean air to the basement. In a subsequent article we propose to refer to the cooling plant in greater detail.

(To be continued)

European Trade in Electric Power

The United Nations Economic Commission for Europe (E.C.E.), has published a report entitled " Transfers of Electric Power Across European Frontiers." It is the first major study made by E.C.E. of the possibilities for international trade in electric power. The report shows the uneven distribution of electricity supply resources in twenty-six countries west of the U.S.S.R. A number of broad schemes are suggested for international transfers of regular supplies of electrical power to needy regions. Below we summarise the principal points brought out in the report and give its main conclusions.

A SPECIAL section of the E.C.E. report* on electric power transfers in Europe is devoted to a general analysis of transfers of electric power across frontiers. The present role of electric power exports in relation to exports of other commodities is indicated by the following figures of exports to countries of Europe as a percentage of total European production in 1950: coal, 12 per cent; steel, 10 per cent; electric power, 1·3 per cent.

Electric power production in Europe (not counting the Soviet Union), expressed in 10^9kWh, increased from 49 in 1920, to 288 in 1950, and is expected to rise to 409 in 1955. This represents both a relatively high level of efficiency in plant operation and the rapid pace with which the traditional natural resources for electricity production are being developed, it says.

Hydro-Electric Reserves

The report shows that even if all countries pooled their water power resources the total economically capable of development for hydro production would be exhausted in a little over twenty years, assuming that water power would maintain the same proportion of total electricity production as at present. If all European countries were thus interconnected and their hydro production was shared equally among all consumers, only 1200kWh per head would be available annually. But only six European countries have sufficient hydro potential to satisfy a yearly consumption per head (of the present population) of more than 2000kWh—

* Published by Electric Power Section, United Nations Economic Commission for Europe, Palais des Nations, Geneva.

a figure already exceeded by four countries in 1950. In certain countries, the hydro-electric resources are already nearing exhaustion. For example, Italy has already developed 48 per cent of her hydro-power resources, whereas Yugoslavia and Austria—her eastern and northern neighbours—have developed only 2 per cent and 17 per cent respectively.

These facts lead the report to suggest that both the limitation of remaining reserves for hydro-power and the wide variation in potential resources between neighbouring countries, point the way to further transfers of power across European frontiers. In this connection, the E.C.E. study points out not only the well-known importance of such regions as southern Norway, northern Sweden, western Austria, the Alps and the French Pyrenees, but also clearly shows the possible importance, in terms of potential resources, of northern Finland, north-eastern Spain, western Yugoslavia and, to a lesser extent, of southern and western Rumania and northern Portugal.

Thermal Resources

On the subject of thermal production, the report indicates that European reserves of coal, lignite and peat could support European solid fuel production at its present level for more than 1000 years. Thermal-electric power production, 90 per cent of which is at present from hard coal, is, however, already using nearly one-fifth of all solid fuels produced. It is increasing much more rapidly than coal output at a time when coal also is in great demand for other purposes.

Although Europe's total coal reserves can continue to support thermal power production for a much longer period than her water-power resources can support increasing hydro-electric requirements, it is important to make the most effective use of solid fuels for power production.

This means that those coalfields where increasing quantities of low-grade and waste fuel are produced, and other scattered brown coal deposits, which are at present little used, are well suited to support increased transfers of electric power to consuming centres.

Although such low-grade fuels cannot themselves justify transport costs, they can be economically used by suitably designed thermal power stations installed at the mines, with transmission lines to the consuming centres. Poland's coalfields are thus likely to be in a position to produce large quantities of electric power, some of it for export. Costs of production and transmission might justify transfers both to areas of power deficiency, such as Bavaria, and to west European consumption centres over far greater distances.

Important brown coal deposits—in Czechoslovakia and Yugoslavia, for example—might equally contribute to the pattern of electric power transfers which a rational use of natural resources would suggest.

The E.C.E. report puts its conclusions concerning possibilities for international transfers of electric power under the following broad headings: "Guaranteed Supplies," that is important regular exports of energy from a country's relatively lasting surplus of natural hydro-electric or solid fuel resources; and "Exchanges," which are occasional surpluses exchanged as and when available between two countries. The main conclusions of the report on the subject of "Guaranteed Supplies" are summarised herewith.

"Guaranteed" Exports of Hydro Power

Norway.—Barely one-fifth of Norway's economic hydro-electric potential of this country (which amounts to about 30,000kWh per head of the 1950 population per annum), is at present being used. Thus, Norway is one of the few countries which could guarantee regular exports for some twenty years, without prejudicing its own domestic supplies. Admittedly, the possibilities are somewhat limited by the country's geographical situation and by the fact that the main river systems still to be harnessed lie in the west. There appear, however, to be several possible solutions.

The nearest thermal area is in Denmark, whose hydro-electric potential is nil. The south of Norway could be connected with this peninsular by a direct-current submarine cable. However, the shortest distance across the Skagerrak is about 150km, and it is not yet possible, in the present state of submarine cable technique, to contemplate spanning such a distance.

If the link is to be made by land, the power will have to be transmitted across southern Sweden and thence via the Zeeland and Funen Islands. The distance in this case would be much longer, namely, between 600km and 700km, but still not great enough to make the transmission of electric power impracticable. More detailed calculations would have to be made in order to assess the relative economic advantages of such a link, which would undoubtedly enable Denmark to save coal.

Another possible scheme would be to export Norwegian power to the southern half of Sweden, the hydro potential of which, as is shown in the study, is very limited, whereas its consumption is the heaviest in the country. The distance to be covered in this case would be much shorter.

Finally, the manufacture of electro-chemical products or aluminium, both of which require large quantities of electric power for their production, could be developed for export, thereby increasing the volume of indirect exports of power alluded to elsewhere in the report.

Yugoslavia.—On the basis of the 1950 population figures, the complete harnessing of Yugoslavia's hydro potential would provide about 3000kWh per head per annum.

The relative importance of this potential is further enhanced by the following factors. First, the productive capacity of sites so far developed is only about 3 per cent of total possible output. Secondly, the neighbouring countries either have a lower power potential (Albania, Bulgaria, Greece, Hungary), or will have completed the development of their main hydro-electric resources in the near future (in the case of Italy, for example, within about ten years). Thirdly, the development of the coastal section of the Dinaric Alps would provide a considerable amount of winter power. Fourthly, construction costs seem to be relatively low, owing to the characteristics of the natural sites, particularly in the area mentioned above. Finally, the country also possesses solid fuel resources which enhance its overall power potential.

On the other hand, consumption of electric power per head per annum, being at present very low, will tend to expand during the next few years more rapidly than the rate empirically forecast for those countries where consumption is already reasonably high.

Nevertheless, the report expresses no doubt that, without prejudicing its own requirements, Yugoslavia will be able to export considerable quantities of electric power regularly and for a long enough period to justify the creation of a special transmission network.

In present circumstances, Italy seems to be Yugoslavia's appropriate hinterland economically. The distance from the centre of the production sources to the Italian frontier is of the order of 400km, and could be spanned with a 220kV or 380kV network. Italy is mentioned first because she has already reached an advanced stage of hydro development, whereas in the case of Albania, Bulgaria, Greece and Hungary, it will take considerably longer to harness all possible development sites. Moreover, the supply of power to Italy would make it possible to envisage, at a later stage, indirect supplies to Switzerland, whose hydro-electric potential is likewise limited.

At the same time, the existence of large deposits of bauxite in Yugoslavia must not be overlooked. As in Norway, use on the spot of electric power availabilities to manufacture aluminium for export is feasible. In that case, it would be preferable to concentrate the industry in the south of the country, farthest away from the Italian and Austrian frontiers.

Finally, the development of submarine cable technique would, in this case, too, enable power to be exported directly across the Adriatic from southern Yugoslavia to southern Italy, but several years must elapse before this can be contemplated.

Austria.—The regular exports of electric power from the Tyrol and Vorarlberg to western Germany have for long constituted a typical example of "Guaranteed Supplies" from a hydro-electric to a thermal region. In Austria, barely one-fifth of hydro-electric potential, which amounts to 4200kWh per head of population, has so far been harnessed. The country's resources will, in all probability, be sufficient not only to satisfy internal consumption needs, despite the present very rapid expansion of demand—which is itself in striking contrast to the trend of consumption between the two wars—but also to enable Austria to export electric power to the north for another fifteen to twenty years. The geographical situation of the country and the localisation of its resources, however, suggest other combinations.

In the western part of the country the potential is very high—more than 12,000kWh per head per annum—whereas consumption is relatively low. By contrast, the eastern part, including the Vienna district, has a potential of only about 2000kWh per head per annum, while its consumption is much higher. Thus, within the country, hydro power tends to flow from west to east.

The west of Austria, which is an area of surplus power, is sandwiched between areas with a high density of consumption, and a hydro-electric potential in an advanced stage of development (Switzerland, Italy), whereas the east, which has a deficit of power, borders on countries, such as Yugoslavia, which, as has been seen, enjoy possibilities of exporting power for a long time to come.

Hence, without looking beyond the possibilities of guaranteed hydro-electric power supplies, the idea of an indirect supply operation has much to recommend it. This would consist in Yugoslavia exporting power to eastern Austria, thereby releasing part of western Austrian production for the use of its neighbours to the west and north.

There are, according to the report, other areas from which regular exports are feasible. While they would admittedly be shorter term ventures, than the preceding cases, the necessary transmission lines would also be shorter.

Sweden.—A conceivable development is a line crossing the northern frontier of Sweden into Finland, and thus linking the far north of Sweden with the important Finnish river basin in the Kemi-Oulu area. The distance between the Swedish and Finnish hydro basins in that area is less than 200km. The construction of such a transmission line would mean that Finland could be provided with additional supplies of hydro power that would be all the more welcome in that Finland is now harnessing its last available resources to supply the southern part of the country.

Rumania.—Rumanian hydro-electric potential represents about 1300kWh per head per annum, a figure comparable with that of France or Spain. But barely 1 per cent of it has been harnessed so far. Rumania could thus contemplate exporting regular supplies to less richly endowed Hungary or Bulgaria. The recent establishment of a 60kV interconnection line with Bulgaria shows that Rumania is already looking in that direction.

It would be interesting to study the possibility of a link between Rumania and Poland, which could tap the surplus power of Slovakia (an area rich in hydro-electric resources), on the way. Such a link would require the construction of only about 300km of transmission line.

"Guaranteed" Exports of Thermal Power

The possibility that the extensive brown coal and low-grade coalfields of Central Europe might become a source of regular power exports, is visualised in the report, which draws five main conclusions on the subject.

(1) Power from Czechoslovakia and Poland could, in the first place, be used to supply southern Germany, chiefly Bavaria, the greater part of whose hydro-electric resources have already been harnessed.

(2) A link between Czechoslovakia and eastern Austria would enable Austria to take supplies of thermal power, just as in the case of hydro-electric power it would, as previously pointed out, be of advantage to this region to take supplies from Yugoslavia.

(3) The fact that Yugoslavia possesses large reserves of brown coal is also worth mentioning, since these reserves are apparently of the same order of magnitude as those of Czechoslovakia.

This fact serves to enhance the advantage to Yugoslavia of the suggested links with Italy and Austria. It also makes it possible to contemplate the export of base-load power to Hungary or Bulgaria, once the energy economies of those two countries have been sufficiently developed to receive it.

(4) Theoretically, there seems no reason why the thermal power to be produced by power stations sited in the Katowice basin in southern Poland and burning low-grade fuel cannot be transmitted to the countries of Western Europe over distances of up to 1000km. This would, in any case, release a large tonnage of commercial coal for other uses.

(5) Although the brown coal and coal waste reserves of the Rhineland coal field and the Ruhr mines will in time be absorbed by Germany's own requirements, they are so vast as to make it feasible to export power for several years over existing transmission lines—to Belgium and France, for example.

A Radio Transmission Line Exchange

The transmission line exchange described below is installed in a Royal Naval wireless telegraph station, where its function is to allow connection to be made between any one of a number of transmitters and any one of several aerial feeder systems. The exchange was built by P. and L. Miller, Ltd., London, E.1, to a specification devised by the Admiralty Signal and Research Establishment. In this exchange manual operations are reduced considerably : one group of the switching movements is motor-driven and provision is made for converting the other group to motor drive if required.

IN 1947 an opportunity arose to make a new approach to the design of the transmission line exchange at a Royal Naval W/T station. Here the standard transmitting aerial feeder system consists of a balanced open twin wire line of No. 8 S.W.G. hard copper, with a spacing of 10in, and a characteristic impedance of about 600 ohms.

The fundamental requirement at this particular station was to devise a means of effecting a junction between any one of ten transmitter feeder lines and any one of twenty aerial feeders outside the transmitter building. An exchange of this kind must satisfy three main conditions. First, the standard impedance must be maintained from transmitter to aerial ; accordingly, there must be no stubs, loops, unrelated alteration of spacing and size of wire, or relatively large masses of metal on the lines. Secondly, any contacts must be capable of conducting up to the maximum r.f. power of any transmitter in service, without arcing or undue heating. Thirdly, the connections and change-overs must be capable of being completed quickly and safely.

It was proposed that this general specification should be met by devising a system of pressure contacts connecting each of the outgoing leads to the aerial feeders and (via the moving parts of the exchange) each of the transmitter feeder lines. It was soon apparent that no practical alternative was available to the traditional semicircular framework with a focal point at its geometrical centre—as embodied on a much smaller scale in the orthodox design of selector switch in a telephone exchange. A trial section of exchange was made, based on these ideas, by the Admiralty Signal and Research Establishment. As a result of the satisfactory experience gained from this installation a development contract was placed with P. and L. Miller, Ltd., London, E.1, to produce an exchange suitable for twenty aerials and ten transmitters with power outputs up to 25kW.

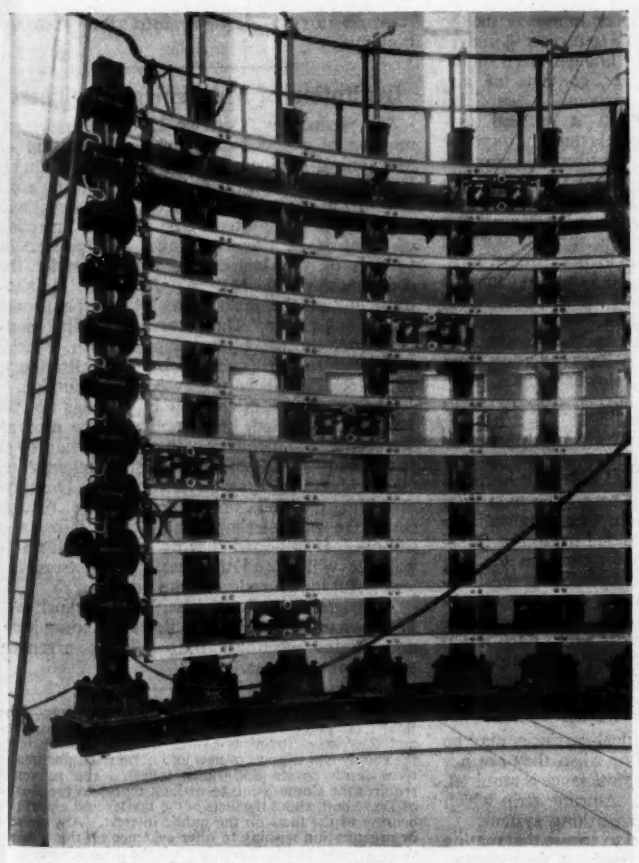


Fig. 1—Part of Radio Transmission Line Exchange

A portion of the finished exchange is illustrated in Fig. 1. Briefly, the equipment consists of a semi-circular structure supported by a number of accurately aligned cast iron vertical columns, so spaced that their side faces form guides for twenty carriages each of which can be traversed vertically between a pair of columns. Eleven equally-spaced semi-circular rails are secured horizontally by brackets bolted to the inner faces of the vertical columns. These rails form the tracks and guides for ten carriages which traverse horizontally. Each of the twenty vertical-traverse carriages carries a pair of lines from an outdoor aerial feeder to a pair of insulated contacts. A similar pair of contacts on each of the horizontal traverse carriages is connected to a particular transmitter feeder via a lattice tower at the geometrical centre of the semicircular structure. Then, connection between any transmitter and any selected aerial feeder is made by traversing the appropriate horizontal and vertical carriages until their respective contacts are accurately mated.

The dimensions of the semi-circular structure—about 28ft diameter and 16ft high—were dictated by the number of aerials (twenty) and transmitters (ten) to be connected to the exchange and by the specified basic 10in spacing of the twin lines. To build a structure of this size, with provision for accurate mating of the contacts at all points on the horizontal and vertical traverses, imposed the need for considerable accuracy in the alignment of the vertical columns. These columns are of stress-relieved cast iron with machined and ground working faces for the sliding carriages. As shown in Figs. 1 and 2, each column is carried in a pedestal, bolted to a base plate formed from two channel section joists. To allow the columns to be positioned to the required accuracy of 0·004in, at a radius of 14ft from the geometrical centre the pedestals incorporate a number of adjustments (Fig. 2). The feet of the columns are on adjustable three-point mountings so that they can be aligned truly perpendicular. Adjustment is also provided to obtain the radius from the geometric centre and the correct spacing between the columns. The radius and spacing were checked by accurate gauges and the column was then secured. The light-alloy brackets which carry the horizontal rails were machined to gauge to ensure that the tracks remain truly circular when they are bolted to them. All holes were jig-drilled and fitted bolts used wherever accuracy of assembly requires it.

Fig. 2—Base of Vertical Column

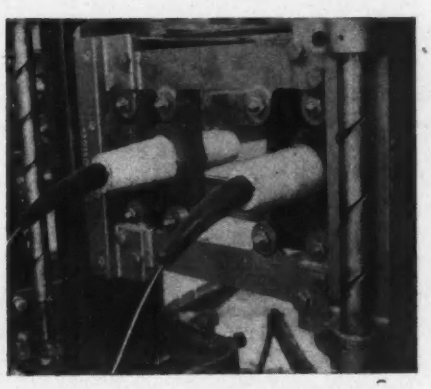


Fig. 3—Vertical Carriage

To allow the structure to expand with temperature without introducing distortion, the channel-section joists are bolted directly to the concrete plinth at the mid-point of the semi-circular arc only. At each end the joists are

held down by a plate bolted to the concrete plinth with a needle-roller between the plate and the joists to allow the latter to expand freely.

Each vertical-traverse carriage (Fig. 3) consists essentially of castings built up to form a rectangular frame which carries the twin flexible phosphor bronze wires from the lead-out fitting on the wall of the building. Each wire is brought through a moulded rubber tail pressed into a porcelain insulator and terminates in a mush-

on the vertical columns. In addition to tracks for the wheels of the carriage, the section embodies an incompletely closed circular slot in the upper and lower faces. "Teleflex" cable is run through the slot on the underside of the rail, and a spring-loaded partial nut secured to the carriage engages in the thread of the "Teleflex," the rotation of which moves the carriage.

Each "Teleflex" is driven at 750 r.p.m. by a small reversible geared electric motor running at

be installed to prevent access to the central towers and the transmission lines. Maintenance is mainly a matter of the regular greasing of the moving parts, for which lubricators and oil wipers have been provided.

Provision has been made for extending the life of certain working parts. For example, the horizontal rails are grooved, top and bottom; the rails can, therefore, be reversed, the flexible lead screw being housed in the second groove.

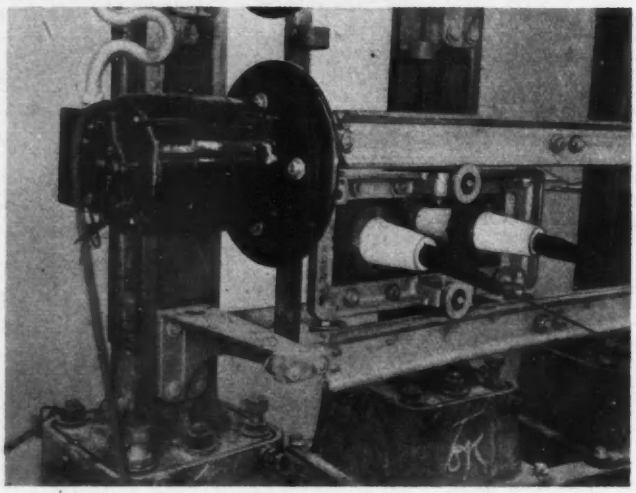


Fig. 4—Horizontal Carriage and Driving Motor

Fig. 5—Carriages in "Contact" Position

room-headed contact at the end of a second insulator. The two porcelain insulators carrying each line are mounted in spring-loaded "Paxolin" bases. Traversing of the carriages is effected by a lead screw; since the travel is short, the lead screws are rotated by hand from a gallery running along the top of the structure. Provision has been made, however, for applying a motor drive and for operating both horizontal and vertical drives by remote control if required.

The horizontal-traverse carriage (Fig. 4) is

1400 r.p.m., which corresponds to a lateral speed of about 14ft per minute. A geared indicator is provided at each of the independent motors which indicates the position of its frame to an accuracy of $\pm\frac{1}{16}$in. Final exact positioning to bring opposing contacts into perfect mesh can be made manually if required, by rotating a small flywheel behind the motor. The operating switch is mounted on the motor.

The spring-loaded contacts mounted in the vertical carriages are adjusted to project $\frac{1}{16}$in over the line traversed by the outer contacts of any horizontal carriage. When a vertical carriage is standing opposite a horizontal carriage (Fig. 5) the opposing contacts are engaged under a pressure, due to the springs, of about 500 lb per square inch. A continuous line is thus established from transmitter to aerial via the central tower and the lines radiating from it, through the mating contacts, to the lead-out line.

The central tower is built of mild steel angles, fitted with teak horizontal bars. The twin lines from ten transmitters are led from the transmitter hall, in the vertical plane, through insulators, to pivot attachments screwed to the front faces of the timber cross bars. Each radial pair of lines leaves the tower in the vertical plane, and is "twisted" to the horizontal plane on reaching its horizontal-traverse carriage.

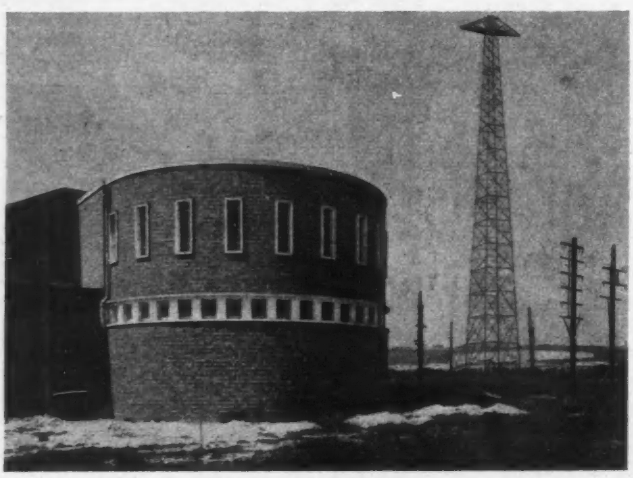


Fig. 6—Transmission Line Exchange Building

similar to the vertical-traverse carriage described above, except that each pair of porcelain insulators is rigidly fixed in its frame instead of being spring-mounted. Radial feeder lines from the tower at the geometric centre of the structure terminate in mushroom-headed contacts at the outer ends of the insulators. The carriage is mounted on flanged wheels, which run on the tracks formed by the rails.

The horizontal tracks are of specially-extruded section of aluminium alloy, accurately rolled to a circle, and mounted on jig-drilled and machined brackets, which are secured to machined faces

Both horizontal and vertical carriages may be brought to "safe" positions when they are not carrying traffic and when maintenance is required. The contacts then bear on a sprung strip which is connected direct to the earthing system.

A "drill" will be instituted to ensure that mating contacts are not broken without first closing down the transmitter concerned. A fence will

The horizontal and vertical carriages are also reversible.

The equipment is housed in a circular brick-built room (Fig. 6) adjoining one end of the transmitter hall. About halfway up the wall there is a row of twenty precast concrete frames holding the 1in thick glass. Around the upper part of the wall there are additional precast concrete frames encasing metal windows, which transmit ample daylight into the exchange building.

Institution of Mechanical Engineers

On Wednesday, October 22nd, the inaugural meeting of a new branch of the Institution of Mechanical Engineers will be held at the Dujon Restaurant, High Street, Bedford, for the election of a chairman, honorary secretary, and members of committee. The inaugural meeting of what is at present known as the Eastern Branch of the Institution, will be under the chairmanship of Mr. A. Roebuck, a vice-president of the institution. After the formal business, a paper "The Measurement and Interpretation of Machinery Noise, with Special Reference to Oil Engines," by C. H. Bradbury, M.I.Mech.E., will be presented for discussion.

The exact area of the new branch has not yet been finally settled, but a notice of the meeting has been sent to members with registered addresses in the counties of Bedfordshire, Buckinghamshire, Cambridgeshire, Essex, Hertfordshire, Huntingdonshire, Norfolk, Northamptonshire (except the Soke of Peterborough), Oxfordshire, and Suffolk. It is hoped that as many members as possible will attend the meeting to ensure the successful inauguration of the branch.

A programme of activities for the branch will be drawn up by the elected officers and committee, and future meetings, &c., will be arranged throughout the area.

Tyres Referred to Monopolies Commission.—The Board of Trade has announced that the Monopolies and Restrictive Practices Commission is to investigate the supply and exports of new and remoulded pneumatic tyres (both covers and inner tubes). The reference requires the Commission to make a report to the Board of Trade both about the facts of the matter and about the bearing of the facts on the public interest. Any person or organisation wishing to offer evidence on this subject should write to the Secretary of the Monopolies and Restrictive Practices Commission, 3, Cornwall Terrace, Regent's Park, London, N.W.1.

Howden Gas Works

AN extensive scheme of reconstruction has been carried out at the Howden works of the Northern Gas Board, which will considerably increase the supply of gas to a common grid serving both sides of the river Tyne. This grid serves the river Tyne area from the sea to the boundary of the Hexham Division, a distance of 24 miles, and extends northward and southwards to the boundaries of the Blyth and Sunderland Division, 10 miles and 7 miles respectively; the Prudhoe unit of the Hexham Division, Morpeth of the Blyth Division and Chester-le-Street of the Sunderland Division being directly connected to the Tyneside grid.

The plant is strategically placed to serve a number of large industrial concerns and the new works are a centre of high pressure gas distribution. Connections to the Sunderland area are eventually visualised as well as in a northward direction to areas which have not previously had a gas supply.

Two projects directly associated with the new plant are of special interest. A main is to be laid direct from the works to supply a large new factory to be constructed by Vickers-Armstrongs, Ltd., which will, in its initial stage, require 40,000 cubic feet of gas per hour, and has an estimated ultimate hourly demand of 100,000 cubic feet. The mains system will also supply a township to be constructed in the Longbenton area by Newcastle Corporation.

The new works replace a plant which was built in 1905/1908, and which occupied an area of about 12·5 acres, and had a nominal capacity of 2¾ million cubic feet per day. It consisted of three benches of horizontal "D" shaped retorts, there being six beds of eight retorts in each bench. Generally, the site occupied by new carbonising units is situated on the area previously occupied by the outside coal store. To provide an alternative store, space for a future gasholder, purifier extensions and also extensions to railway sidings, additional land was purchased, and the total site area now covers about 21·5 acres. The original railway sidings, consisting of four short roads, have been completely relaid and extended to eight longer roads with a shunt leg at the extreme west end.

Coal is delivered in bottom-discharge wagons to either one of two crusher pits, and is elevated by bucket conveyor to reinforced concrete bunkers of 790 tons capacity. These bunkers are each divided into three sections for various classes of coal. Coal is discharged from the bunkers to conveyor belts via three cubimeters, which enable the various classes of coal to be mixed in correct proportions. The coal is taken to four reinforced concrete bunkers, one for each carbonising battery, and each of which has an in and out capacity of 270 tons, equivalent to 48 hours' normal consumption. Separate compartments of 40 tons capacity for the pad coke are provided in each bunker, and the four bunkers are fed from a reversible shuttle conveyor.

The carbonising plant, which, together with the coal and coke handling plants, was supplied by Gas Chambers and Coke Ovens, Ltd., comprises two 4 million cubic feet per day independent carbonising units. Each unit has two batteries, or benches, of eighteen intermittent vertical chambers. Each battery contains three settings of six chambers each. The total number of seventy-two chambers, allowing for scurfing, are capable of carbonising 540 tons of coal per twenty-four hours.

Each battery has its own charging car, and a weighing machine is inserted in the overhead track for each car for recording weights of charges.

Four external self-vaporing mechanical gas producers, housed in a separate building, supply hot clean gas for heating the batteries. Normal daily consumption of each producer is 38 tons of graded coke, and three of the units are capable of supplying the full requirements of the batteries and the diluent for the coal gas. Each of the producers is supplied from an overhead feeding hopper with forty-eight hours' storage capacity.

Each pair of batteries is provided with three waste heat boilers, one of which is a standby, to generate steam at 300 lb per square inch with 100 deg. Fah. superheat. These boilers are housed in the lower sections of the coal bunker house and supply steam for driving exhausters and a turbo-alternator.

Coke from the chambers is discharged into hot coke cars and is hauled to the quenching towers and wharves by electric winches. The wharves for quenched coke are of sufficient capacity to allow two shifts working on coke conveying and grading plant. All coke is handled by belt conveyors which take it to the grading plant or stocking ground. The coke storage hoppers have a capacity of 1040 tons and are divided into six compartments. A wet purification plant was installed by W. C. Holmes and Co., Ltd., and a dry purification plant by the Oxley Engineering Company, Ltd.

Two independent gas streams, each of 4 million cubic feet per day, pass through two condensers to an exhauster and of the five condensers, one acts as a standby to serve either unit. One of three steam-driven Connersville exhausters installed is provided for a standby unit. Three sets of secondary condensers and three sets of detarrers each have one standby unit to serve either stream. Each stream of gas passes to two four-bay ammonia washers connected in series and on the outlet of each washer stream two extra bays provide an oil wash prior to oxide purification.

Before purification, the gas passes through gas heaters to two 4 million cubic feet per day elevated purifier boxes. The purifier structures consist of a steel-framed building with an upper concrete revivifying floor, and one structure is provided with overhead cast iron tanks for the storage of town's and recirculated water. Two Connersville meters, each having a capacity of 200,000 cubic feet per hour, are provided for coal gas. Benzole is extracted by oil washing, followed by vacuum distillation. One 4½ million cubic feet per day C.W.G. plant, complete with exhauster, detarrer, purifiers and meter, was supplied by Humphreys and Glasgow, Ltd., and provision has been made for the duplication of this plant.

An existing 1 million cubic feet capacity column-guided gasholder acts as a relief holder for the C.W.G. plant, and an existing 3 million cubic feet capacity spirally-guided four-lift gasholder is used for the storage of coal gas. Provision has been made for a further 3 million cubic feet capacity spirally-guided gasholder.

The original boosters will be retained and, in addition, a 250,000 cubic feet per hour steam-driven positive machine, capable of delivering gas at 30 lb per square inch has been installed.

Steam from the waste heat boilers of the carbonising plant is used for the generation of electricity by a 530kW Allen turbine-driven alternator. The generating plant is connected with the public mains, which provide a standby supply, and are available to receive any surplus electricity generated by the works' plant.

A combined natural and forced draught reinforced concrete cooling tower, with a rated capacity of 179,000 gallons of water per hour, has been supplied by the Davenport Engineering Company, Ltd., to economise in the use of water.

A six tons per day capacity sulphate plant, built by Geo. Royston and Son, Ltd., deals with the liquor yield of the works, with possible supplementation from other works.

All ash and breeze from the producers and C.W.G. plant is handled by belt conveyor and skip hoist to a twin reinforced concrete hopper arranged for road discharge to lorries.

STRUCTURAL COURSES AT BRIXTON SCHOOL OF BUILDING.—A course of twenty-four weekly lectures on prestressed concrete is being provided this year at Brixton School of Building. A tutorial and laboratory class (commencing October 6,) will be held in addition to the lecture course. Dr. P. W. Abeles is the principal lecturer. Mr. S. M. Reisser is the principal lecturer in the welded structures course. Further details of the courses may be obtained from the Secretary, L.C.C. Brixton School of Building, Ferndale Road, London, S.W.4.

Magnetic Filtering Plug

A VERY simple magnetic oil filtering agent is now being manufactured in this country by Uniscan Products, Ltd., Oak Cottage, The Mall, London. The magnet consists of a small cube of sintered metal which is claimed to be highly magnetic and able to maintain its magnetism indefinitely with this shape and without a keeper. It is stated by the makers that previously there was no steel available which could be used to make a short bar magnet and able to fit in the very small clearances in the crankcases, gearboxes and back axles where it is housed in drain plugs of the same size and dimension as those they replace.

The plug is able to retain hard metallic particles and is fully capable of retaining a broken gear tooth. The metal was first discovered in Sweden, where the use of these plugs is obligatory in the armed services. The sole distributors in this country are Parion Products, Ltd., Parion House, Witham, Essex.

Prefabricated Aluminium Bungalows

WE were able to see this week some prefabricated aluminium bungalow clusters, designed particularly for hot climates. These units are made at the Royal Burgh of Irvine, Ayrshire, and they are marketed overseas by Booth and Co. (England), Ltd. The basic unit from which the bungalow cluster is formed is itself a self-contained building of vertical aluminium 13 S.W.G. sheets, formed in a circle and closed by roof sheets of 14 S.W.G. aluminium sheet rising from 6ft 7in at the eaves to 10ft at the apex.

The structure is rigid and needs no specially prepared foundations. This circular unit weighs 800 lb, and it can be bolted together in about forty minutes by four unskilled men. Another unit is called the "Ovaltent," which has circular ends and a parallel-walled centre section. This structure and two circular units form a bungalow cluster, with the addition of a standard passage set. Any number of windows can be allowed for. The circular unit when packed for export occupies 70/80 cubic feet.

Control Tower at Luton Airport

AT Luton Municipal Airport, on Wednesday, September 24th, the Rt. Hon. A. T. Lennox-Boyd, Minister of Transport and Civil Aviation, officially opened the new control tower. The structure, though strictly functional, is an imposing one. It has four storeys, reaching to 52ft 6in, the top floor of which serves as the actual control room, standing 42ft above the ground and from which a commanding view of the airport and its approaches is obtained. The windows on this floor, as is often the practice with control towers, are sloped inwards, which tends to eliminate reflection at night and is advantageous in heavy rain. A balcony extends around the entire control room. All the floors are served by a spiral staircase. The ground floor will be used as a reception room where pilots will report their arrival or destination, together with details of passengers and freight, if carried. It is intended that the first floor will be developed in the future as a meteorological office, whilst the second will be used as a records office and teleprinter room. On the third floor is an equipment room where the main v.h.f. R/T equipment is housed, and a standby battery plant which comes into operation automatically in the event of failure of the main supply. In the control room there is transmitting and receiving equipment for v.h.f. R/T, as well as a Marconi AD.200 v.h.f. D/F apparatus, together with telephones, crash alarms, wind speed and direction indicators, all of which equipment has been built into the control officer's desk which faces directly on to the airfield. The building was designed in the borough engineers department of the Corporation. Luton airport was officially opened in July, 1938, and it now covers 483 acres, which is all grass. Plans have been completed covering the erection of additional hangarage space, together with a concrete runway and full night lighting facilities.

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THE AUSTRALIAN ATOMIC EXPERIMENTS

When it was announced some months ago that the three British Defence Services with the Ministry of Supply would carry out, in association with the Royal Australian Navy and the Royal Australian Air Force, a joint operation to test a device briefly described as "Britain's atomic weapon," it was explained that the test, for reasons easily understood, would be made not in the British Isles, or even its neighbouring waters, but in the proximity of the Monte Bello islands lying off the north-west coast of Australia. Many people had probably never heard of the existence of these now much-publicised islands, and the further information that they were situated about 25 miles from the port of Onslow did not make them feel much wiser. But what certainly was very well known was that there already existed in Australia a considerable experimental area in which for some years a highly skilled technical staff had been carrying out important Combined Defence experiments; the area chosen was a sparsely inhabited section of the State of South Australia, and the tests were stated to be on various forms of guided missile. The base was at Salisbury with an advance establishment at Woomera, some 350 miles north of Adelaide; between the two there now exists a daily air service for passengers and freight. At Woomera there has grown up a township of some 2500 persons, which the Director-General of Technical Development at the Ministry of Supply in a recent visit described as inspired by a praiseworthy singleness of aim and of comradeship in important pioneering work. The Australian Department of Civil Aviation has for the present tests banned flying over the Monte Bello Islands and the large triangular area of the mainland between them and Woomera.

No details have been published of Britain's atomic weapon or of the guided missiles themselves. But since some of the many varieties of the latter are expected to include atomic warheads it would be but natural that there should be a close relationship between the two lines of investigation; both are to take place in Australia, and the relative scarcity of any considerable supply of scientists and technicians skilled in atomic physics and electronic engineering suggests the advisability of a combination of effort. The guided missile need carry no human pilot and will, in general not, do so, hence in one of its forms it calls for some automatic means for guiding itself towards its target—in most cases, no doubt, a raiding bomber flying at very high speed and altitude. Such bombers must always be hard to intercept by ordinary high-speed fighters since the margin of speed is not likely to be great enough; but the guided missile can have ample speed for any such task. It must be remembered that for interception it is not sufficient merely to follow a course aimed directly at the target, even with the high speed the interceptor may possess. The route by which a dog follows his master is not usually the shortest, and it is easy in a mathematical class-room to show possible times of interception which tend towards the infinite! That a stern chase is a long one is a familiar proverb, and as everyone knows it is better to aim well ahead and so cut off the hunted quarry. This can be no simple matter for an uninspired, self-contained mechanism to carry out, and it may be that when future years reveal the secrets of to-day it will be found that television apparatus has been adapted to enable a distant, and human, ground controller to note the bearing of the target as it would be seen from the nose of the pursuing missile and so to guide it by radio as to produce the desired rapid interception, with a degree of closeness sufficient to cause a proximity fuse to blow the warhead, atomic or otherwise, with destructive effect on the target.

According to Press statements, Sir John Cockcroft, the head of the British Atomic Energy Research Establishment at Harwell, will be in charge of the Monte Bello experiments and it is also stated that the British atomic weapon to be tested is likely to be equally suited for use in a bomb, a guided missile or an artillery shell. Whether it will be tested in all of these forms or in one or two only is, so far as the public is concerned, anyone's guess. These are, of course, but a few of the possible hypotheses of what may be embraced in these important and comprehensive investigations; the justification for discussing them is that inventive genius, even though deeply engaged in totally different work, has not infrequently intervened with strikingly useful suggestions in novel fields of experiment. It may therefore be fully well worth while to set out in these pages some of the general reflections to which the work in Australia gives rise, even though it must be admitted that the lead given by any official information so far issued is exceedingly slender.

HYDRO-ELECTRIC POWER AND MIGRATORY FISH

It is not only in the Highlands of Scotland and elsewhere in the British Isles that the problem of getting migratory fish past dams is encountered. In the Pacific North-West of the United States it is proving a problem more difficult to solve than here, because of the scale effect produced when dams are very high, and the high cost and doubtful efficiency of very long fish ladders. In an attempt to prove that fish and dams can live together in that region, both private and public builders of dams are to-day operating fish ladders, buckets, boats and tank wagons to help the fish on their upstream journey to the spawning grounds. This practical experience with fish protective measures and current research work is expected to point the way to a solution of a problem which has led to much bitter controversy in the north-west; preserving the lucrative fishing industry and, at the same time, developing the power potential of the Columbia River and other streams. Ever since large dam construction schemes have been initiated, the future of the salmon industry has troubled the residents of this part of America. Without protective devices, large numbers of fish were lost each year as they went upstream to spawn and many fingerlings failed to survive the return journey. Finding Congress reluctant to make appropriations for dam projects that fishing interests claimed would doom the salmon industry, the U.S. Army Corps of Engineers and other advocates of hydro-electric power generation, informed the U.S. Fish and Wildlife Service that they were prepared to follow any steps in the construction of dams which would help to keep the salmon industry alive. Unfortunately, the Fish and Wildlife Service did not at that time know how to preserve the salmon short of halting dam construction. It decided, therefore, to call on fisheries and game departments of the North-West States and of British Columbia and on international salmon agencies, requesting co-operation in a suitable research programme. It has been estimated that at least three years will be required before many of the answers can be found. In the meantime, dam construction will proceed taking advantage of presently known fish conservation practices with the understanding that further measures will be added later.

Devices for getting the fish upstream have been fairly successful already in the U.S.A. as in Britain. The Puget Sound Power and Light Company has fish-protective facilities at each of its three dams on the Baker, White

and Columbia rivers. The Rock Island dam has three ladders, situated in the middle and at each end. These ladders were built in 1933 at a cost of 600,000 dollars and have been operated successfully since 1939 by the Fish and Wildlife Service. It is of interest to note that the count of salmon to-day is higher than in 1933. Baker River salmon are caught in a fish trap which spans the river below the dam and are carried some 400ft in a water-filled tank wagon on a narrow-gauge track to aerated holding pools. Here they are lowered into a water-filled bucket which is picked up by an aerial cableway for a 900ft journey over the dam at the end of the day. If the dam gates are open the fish take another journey for a mile upstream in a boat, to prevent them drifting down and spilling over the dam. At the Bonneville dam, on the Columbia River, gravity fish ladders have been in operation since 1938. Fish locks were installed, too, but are used only experimentally. The McNary dam, which is still under construction, will eventually have both fish ladders and locks, but the locks will be for emergency and experimental purposes only. It will be seen that the problem of getting spawning salmon upstream past even a high dam is certainly no longer insurmountable. But great difficulties are still being experienced in safeguarding the young fingerlings going downstream to salt water. They cannot be kept out of turbine intakes as easily as the large fish. Some of them are injured by abrasion in going through the turbines. More lethal, probably, is the rapid decompression as they pass from the penstock through a high-head turbine runner into the draught tube. With the present tendency toward greater turbine heads, the danger to fingerlings becomes even more serious. Certain experiments to determine the mortality rate of fingerlings have been conducted at the Baker River dam, and it has been reported unofficially that only about a third of the fingerlings have succeeded in passing the works unharmed !

In the U.S.A. there is a strong political element in the fish dam controversy. The fisheries' interests have been able to obtain substantial support from the many followers of the fishing sport in the state of Washington. One aspect that irritates the dam builders is the distrust in which private power has been held in Western Washington, a distrust that sometimes has been transferred to public power generating agencies whenever they wanted to construct a dam in a fish stream. But the advocates of dams have been winning more public support in recent years by pointing out that hydro-electric power can provide more employment than the fisheries industry, and by suggesting that the decline of fish runs has been due more to the greed of commercial fishermen and stream pollution than to dam construction. The obvious, though far from simple way to end such controversy is to prove by continued research that both multiple-purpose reclamation schemes and the fishing industry can function side by side. The right spirit was expressed in a recent statement of official policy by Mr. Michael W. Strauss, the American Reclamation Commissioner : " There need be no conflict between commonsense irrigation and fish and wildlife development if both will plan and both will work on the basis of the greatest good for the greatest number. Reclamation has supported and does support fish and wildlife development. State organisations and local irrigation districts, I believe, should do likewise. But the way to do this when water development is involved is not to fight to hold back reclamation proposals, but to push forward fish and wildlife proposals." That is a spirit that should apply as much in this country as in America.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

LOCOMOTIVES AND THEIR WORKING

SIR,—I have only just seen your August 22nd number, and am interested to read both sides of the argument about acceleration and size of driving wheel. Granted equal adhesion weights, coefficients of friction and other factors, should it not be a point in favour of locomotives with large driving wheels that they can be driven at longer cut-offs up to higher rail speeds than locomotives with small driving wheels ? If not, why not ?

P. N. D. PORTER

Ras Sudr, September 24th.

MOTIVE POWER FOR RAILWAYS

SIR,—I was interested in the curve shown in Fig. 3, page 429, of your issue, September 26th, particularly with reference to the curve which purports to show the performance of a diesel mechanical (Fell) locomotive, because this curve appears to bear no relation to the power input at the various speeds, and is not characteristic of the Fell system as already applied in British Railways locomotive No. 10,100. There is no flat between 25 m.p.h. and 40 m.p.h. as shown by Mr. Cock. The initial tractive effort for No. 10,100 is quoted by British Railways at 26,900 lb. A static drawbar pull of 11 tons has been recorded on No. 10,100, so that the British Railways figure is not far out seeing that the locomotive had to move itself against the drawbar springs to take up the load. The initial tractive effort is held up to about 12 m.p.h., and then begins to fall, and at about 18 m.p.h. is 22,500 lb. This figure is held till about 30 m.p.h., and then falls steadily until the cut-off speed of 78 m.p.h. is reached.

Below, the horsepower from the tractive effort figures given by Mr. Cock at different speeds are compared with the actual horsepower input from the main engines at the appropriate rail speeds.

m.p.h.	b.h.p. (Mr. Cock)	b.h.p. (actual)
40	1500	1920
50	1600	2040
60	1730	1980

It will be seen that there is a discrepancy between Mr. Cock's figures for horsepower and the true horsepower, of 420 at 40 m.p.h., 440 at 50 m.p.h., and 250 at 60 m.p.h. It is quite impossible that such losses are occurring in the Fell transmission, as if they were the cooling of the transmission system would be wellnigh impossible. As a matter of fact, on No. 10,100, we experience no temperatures in any part of our transmission system which call for the need of coolers. This by itself is sure evidence that our claims for the efficiency of our transmission are fully established. Apart from this, the high performance of the locomotive, which has been checked by many responsible people, provides ample proof that the input power is applied to the driving wheels with very small loss.

On page 430, Mr. Cock states that pressure charging to obtain high M.E.P. at low speeds is accompanied by " very high maximum cylinder pressures." So far as the Fell locomotive is concerned, this is not correct, as the maximum cylinder pressures are controlled within safe limits throughout the speed range.

L. F. R. FELL

London, E.C.3, September 27th.

Short Notices

Automobile Chassis Design. Second edition. By R. Dean-Averns. London : Iliffe and Sons, Ltd., Dorset House, Stamford Street, S.E.1. Price 30s.—This textbook was first published in 1948, and the enlarged second edition includes chapters on the techniques of independent chassis suspension and chassis-less construction as well as new material on methods of stress measurement, anti-corrosive treatment of metals, road spring design, streamlining, &c. It deals largely with the design problems of heavy commercial and public service vehicles, but is stated in general to be equally applicable to the lighter field of motor car design. The information given in the book is amply supplemented with diagrams, drawings and photographs. Both designers and students of motor vehicles will find the new edition of the book a useful up-to-date work of reference to keep in their libraries.

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Materials Handling in Industry. London : The British Electrical Development Association, 2, Savoy Hill, W.C.2.

Guide to the Coalfields, 1952. London : The Colliery Guardian, 30/31, Furnival Street, Holborn, E.C.4. Price 20s.

Statistical Tables and Formulas. By A. Hald. London : Chapman and Hall, Ltd., 37, Essex Street, W.C.2. Price 20s.

Fachworterbuch Werkzeuge. By Henry G. Freeman. Germany : Verlag W. Girardet, Essen, Gerswidastrasse 2.

Forging and Forming Metals. By S. E. Rusinoff. Surrey : The Technical Press, Ltd., Gloucester Road, Kingston Hill. Price 32s.

Steelwork in Building. By W. Basil Scott. London : E. and F. N. Spon, Ltd., 15, Bedford Street, Strand, W.C.2. Price 25s.

Les Machines Thermiques. By P. Chambadal. Paris-V^{e} : Librairie Armand Colin, 103, Boulevard, Saint-Michel. Price 260 Fr.

Modern Locomotives. Second Edition. By Brian Reed. London : Temple Press, Ltd., Bowling Green Lane, E.C.1. Price 9s. 6d.

Steam Trap Maintenance. By A. S. Wadsworth. Manchester : Emmott and Co., Ltd., 31, King Street West, 3. Price 2s. 6d.

Marine Refrigeration. By R. Munton. London : Modern Refrigeration, Empire House, St. Martin's-le-Grand, E.C.1. Price 7s. 6d.

Electrical Who's Who, 1952. London : Iliffe and Sons, Ltd., Books Department, Dorset House, Stamford Street, S.E.1. Price 12s. 6d.

Statistical Theory with Engineering Applications. By A. Hald. London : Chapman and Hall, Ltd., 37, Essex Street, W.C.2. Price 72s.

The Cold Working of Non-Ferrous Metals and Alloys. London : The Institute of Metals, 4, Grosvenor Gardens, S.W.1. Price 15s.

Forces in Framed Structures. By T. Lyle Morgan. London : Eyre and Spottiswoode (Publishers), Ltd., 15, Bedford Street, W.C.2. Price 25s.

Mechanics of Vibration. By H. M. Hansen and Paul F. Chenea. London : Chapman and Hall, Ltd., 37, Essex Street, W.C.2. Price 64s.

The Artificial Satellite. Edited by L. J. Carter. London : The British Interplanetary Society, 12, Bessborough Gardens, S.W.1. Price 5s.

Fourth Conference on Chemical Works Safety. London : Association of British Chemical Manufacturers, 166, Piccadilly, W.1. Price 7s. 6d.

Wireless Fundamentals. By E. Armitage. London : Sir Isaac Pitman and Sons, Ltd., Pitman House, Parker Street, Kingsway, W.C.2. Price 18s.

Directory of Railway Officials and Year Book, 1952–1953. London : The Railway Gazette, 33, Tothill Street, Westminster, S.W.1. Price 40s.

The Structure and Properties of Mild Steel. By C. A. Edwards. London : Quality Press, Ltd., Bouverie House, Fleet Street, E.C.4. Price 20s.

X-Ray Crystallographic Technology. By A. Guinier. London : Hilger and Watts, Ltd., 98, St. Pancras Way, Camden Road, N.W.1. Price 56s.

Centenary of Snow Hill Station, Birmingham

It is of interest to recall that 100 years ago, on Friday, October 1, 1852, the first public express passenger train left Paddington on its 129-mile journey, via Oxford, to Birmingham. It was by the Birmingham and Oxford Junction Railway Act of August 3,1846, that a line was authorised from a junction with the L. and N.W. Railway, near Curzon Street, Birmingham, to a junction with the Oxford and Rugby Railway in the Parish of Fenny Compton, whilst a further Act, the Birmingham Extension Act of the same date, authorised a railway in the Town of Birmingham, from a junction with the Birmingham and Oxford Railway at Adderley Street to Great Charles Street. Stations were to be built between Snow Hill and Livery Street and between Monmouth Street and Great Charles Street. A further provision of the Act was that the portion of line between Moor Street and Monmouth Street should be covered by a tunnel, this last provision being interesting, inasmuch as it is the reversal of the usual practice of providing cuttings in order to avoid tunnels whenever possible. The railways were vested in the Great Western Railway, by the Great Western Railway (Additional Powers) Act, August 31, 1848. Construction of this line was started in 1847, the engineer being Mr. I. K. Brunel, and the contractors, Messrs. Peto and Betts.

The opening of the new line was by no means auspicious. On the day prior to the advertised public opening, a special inaugural trip of directors, officers and friends was arranged from Paddington to Birmingham, a special train of ten coaches being drawn by the locomotive, "Lord of the Isles." The journey was, however, not completed, as unfortunately the train came into collision with a local train at Aynho, resulting in the derailment of its engine. Hauled by a replacement, the train finally ran as far as Leamington, where the passengers were joined by guests from Birmingham, who had travelled up in a hastily arranged special train. All appears to have been well on the following day, when the first passenger trains took up the service.

Steel Making Course for Undergraduates

At the invitation of the United Steel Companies, Ltd., thirty-six students of pure science, engineering and metallurgy, from the Universities of London, Sheffield, Leeds, Southampton, Cambridge, Bristol and Birmingham have recently attended a short course on iron and steel making in Sheffield as guests of the company. The aim of the course was to give an insight into the scientific foundation of iron and steel making and of certain derivative chemical manufacturing processes, and the scope of engineering and research in the industry. Some idea, too, was given of the economic structure of the industry. An indication was therefore conveyed to the undergraduates of the opportunities available within the steel industry and it is hoped that it will benefit those who attended and will assist them in deciding the sort of career they would like to follow when coming down from their universities.

The undergraduates were in residence at University Hall, Sheffield, under the supervision of Mr. T. Fletcher, the company's training supervisor. During their week's visit they studied the work of a fully integrated iron and steel plant at Appleby-Frodingham Steel Company, Scunthorpe; visited the company's new research and development department at Swinden Laboratories, Rotherham; observed the manufacture of alloy steels and finishing processes such as fine wire, stainless steel and cold rolled precision strip at Samuel Fox and Co., Ltd., Stocksbridge, and visited the works of Steel, Peech and Tozer, Rotherham, and the United Coke and Chemicals Company, Ltd., Treeton. The undergraduates were entertained to dinner each evening at University Hall, where they met representatives of the board, management and head office staff, and had the opportunity of discussing points of detail with them.

The Commercial Motor Show

No. II—(*Concluded from page 424, September 26th*)

While the first part of this article dealt mainly with the heavier commercial vehicles, this second part gives an account of the lighter models and describes some of the more interesting technical improvements relating to major vehicle components and to some proprietary units such as engines, transmissions and brakes, &c.

Among exhibits at the stand of Vauxhall Motors, Ltd., the Bedford 10/12 cwt van, which was first marketed last April, attracts great interest. Though 16in shorter than the van it supersedes, the new Bedford (Fig. 7) van is more powerful, more economical, and provides 80 per cent greater body space. The vehicle has semi-forward control, sliding doors at each side, an all-steel body, and is powered by the 1·5 litre, short-stroke engine of the latest Vauxhall "Wyvern" car, which develops 40 b.h.p. at 4000 r.p.m. The vehicle is fitted with a three-synchro-mesh gearbox with the gear lever mounted on the steering column, a tubular propeller shaft and a semi-floating hypoid drive rear axle. The engine is offset to the left of the centre line of the chassis, giving ample space for the convenient grouping of the controls. The stiff frame has three cross members in addition to the centre cruciform member, and a fabricated cross member of the independent front suspension unit is bolted to the frame side members and acts as an additional cross member. The front suspension is similar to that used in Vauxhall motor-cars, employing wishbone links of uneven length and coil springs in conjunction with concentric double-acting telescopic dampers. Long, semi-elliptic underslung leaf springs with double-acting dampers form the rear suspension.

The all-steel body is designed to facilitate loading and to make the best use of the available space a one-piece steel pressing supported on pressed steel hoops, serves as the roof and the sides are one-piece steel pressings strengthened by inner steel panels, which extend to the waist. The front doors are carried on spring-loaded rollers at the top and at the bottom and slide on the outside of the body, while the rear doors are carried on self-aligning hinges. The vehicle has a wheelbase of 7ft 6in and is designed for 135 cubic feet load capacity, fully accessible from front and rear, with an additional 10 cubic feet beside the driver when the optional passenger seat is not fitted. A small turning circle of only 33ft makes this van very manœuvrable and, therefore, particularly suitable for local delivery work.

Apart from Sentinel, Ltd., pioneers of the underfloor engine, the two amalgamated firms of Commer Cars, Ltd., and Karrier Motors, Ltd., were among the first to introduce those engines in goods vehicles. At this year's exhibition Commer Cars, Ltd., shows some improved versions of its 1951 models, while Karrier Motors, Ltd., displays a new range of underfloor engined vehicles to replace the previous "CK 3" 3–4 tonner.

Of the same load carrying capacity and available with alternative wheel bases of 9ft 7in and 11ft 9in, the new Karrier "Gamecock" chassis will, apart from general transport duties, form the basis of a range of municipal appliances such as refuse collectors, tippers, tower wagons, gully emptiers, &c. The main feature of this chassis is an entirely new six-cylinder o.h.v. petrol engine of 3·75in bore and 4·375in stroke of 4·75 litres capacity. The engine develops 85 b.h.p. at 2600 r.p.m. and is located in three-point rubber mountings underneath the floor. It is characterised by the use of chromium-plated cylinder bores and a crankshaft of generous dimensions carried in seven bearings. Other noteworthy details include a low-load, deep-section chassis frame, essential for municipal work and useful for many industrial purposes and a four-speed gearbox with constant-mesh helical top and third gears; the spiral bevel rear axle has fully floating shafts and the hydraulic two-leading-shoe brakes are servo-assisted.

A general purpose truck driven either through the rear or through all four wheels

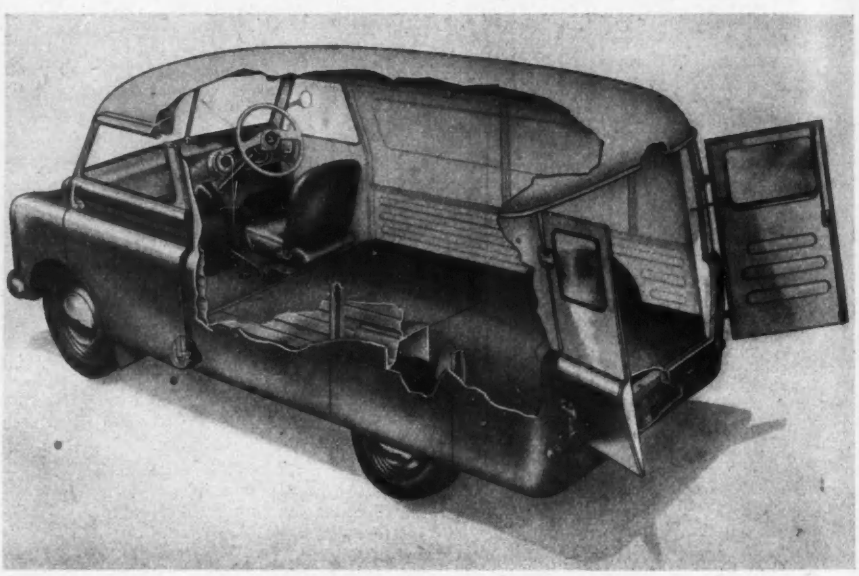


Fig. 7—Bedford 10/12 cwt Van—Vauxhall

Fig. 8—One Ton Capacity, Four-wheel Drive Military Vehicle—Austin

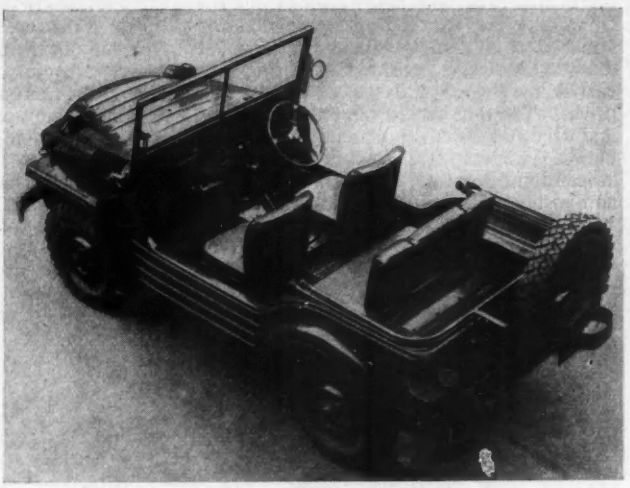


Fig. 9—Four-wheel Drive Personnel Carrier—Austin

for military requirements and able to operate across fields, swampy ground or in the desert, makes its first public appearance at the stand of Morris Commercial Cars, Ltd.

This all-purpose model has a flexibly mounted, six-cylinder, o.h.v. petrol engine of 4·2 litres capacity which develops 72 b.h.p. at 2750 r.p.m. The four-speed gearbox is coupled to an auxiliary transfer box to provide a high drive of 1·1 : 1 for either two or four-wheel drive or a low four-wheel drive ratio of 2·1 : 1, thus giving overall ratios of eight speeds forward and two reverse.

Varying body designs can be fitted to this chassis but the general service body, made of steel and equipped with detachable canvas sheet and tubular steel hoopsticks, will accommodate either cargo or personnel.

Another exhibit of Morris Commercial Cars, Ltd., is the new forward-control, 1½ ton L.D.2 van, which is powered by a four-cylinder, o.h.v. engine and has a four-speed gearbox with provisions for a power take-off. The styled body with a capacity of 235 cubic feet, has flush-fitting sliding doors, both offside and near-side, with wide opening rear doors on outrigger hinges which fold back against the sides.

Prominent at the stand of the Austin Motor Co., Ltd., are three entirely new vehicles, built in accordance with the rearmament programme and designed to military specifications. They are a 1 ton, four-wheel drive truck, a 1/4 ton, four-wheel drive personnel carrier and a civilian version of the latter vehicle for use as a light tractor, general farm vehicle or cross-country transport.

The Austin 1 ton 4 by 4 truck (Fig. 8) is fitted with a 4 litre, o.h.v. petrol engine, which develops 90 b.h.p. at 3000 r.p.m. The main gearbox is mounted in unit construction with the engine and clutch and it has four forward speeds and reverse. An auxiliary gearbox is mounted separately on cross members midway along the chassis. It is driven from the main gearbox by a short shaft and provides the option of a high-ratio drive to the rear axle for normal road conditions, or a low-ratio to both front and rear axles for rough work. Three open, tubular, balanced propeller shafts with Hardy Spicer needle bearing universal joints connect the main gearbox with the transfer box and the transfer box with the front and rear axles. The rear axle is fully floating with straddle mounted spiral bevel pinion, and the driving shafts, which are only stressed by torque, can be dismantled, together with the differential assembly, without jacking the wheels. The axle casing is built up of high-grade steel tubes and a cast steel centre case. The front axle has the same centre casing and the same spiral bevel and differential assembly as the rear axle and these parts are interchangeable. Heavy section tubes support the swivel ends and strong alloy steel shafts drive, by means of "Tracta" constant-velocity joints, the stubs, which are flanged and studded to the hubs. The body is constructed of folded steel panels and the sections are welded together. The sub-assemblies are bolted together to form a structure in which damaged portions can easily be replaced.

The Austin 1/4 ton, four-wheel-drive personnel carrier (Fig. 9) has a four-cylinder engine of 2·66 litres capacity, which in all major details is similar to the six-cylinder engine on the 1 ton truck. It develops 78 b.h.p. at 3750 r.p.m. and has the remarkably high compression ratio of 7·5 : 1. The gearbox has five forward speeds with synchro-mesh engagement for all speeds. The reverse gear is carried in the transfer gear casing and is selected by a lever having three positions, forward, reverse or winch. The drive can be transmitted either to the rear wheels only or to all four wheels at once. One open propeller shaft conveys the drive from the gearbox to the rear axle and a second shaft drives the front axle from the rear transfer case ; it runs idly when the front wheel drive is not in use.

The front axle has a hypoid bevel gear in a cast aluminium case. The crown wheel carries a straight-tooth bevel differential, and the axle half-shafts transmit the drive to the wheels through constant-velocity univer-

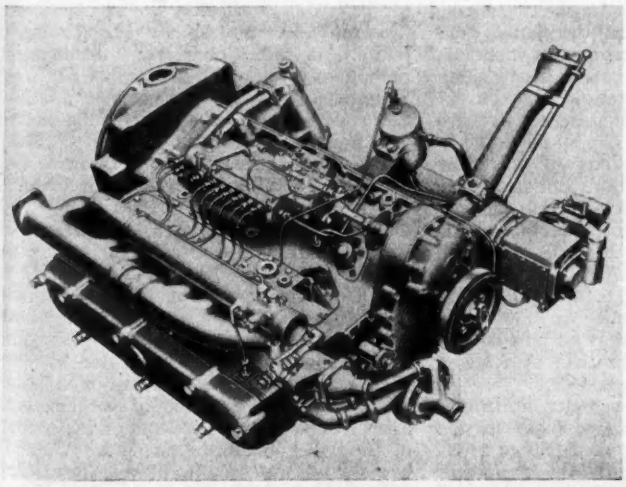


Fig. 10—Six-cylinder, 5·76 litre Horizontal Diesel Engine—Leyland

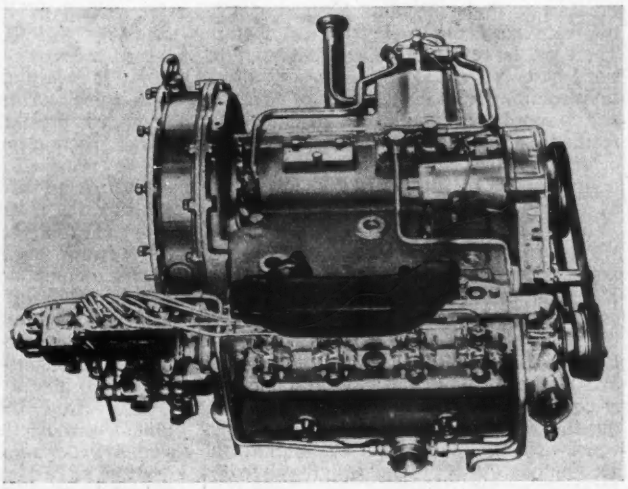


Fig. 11—Four-Cylinder, 3·14 litre, Horizontal Diesel Engine—Perkins

sal joints. The rear axle is similar to the front axle but has a transfer gear casing attached to the forward end of the main axle casing. The transfer gear casing also carries the winch and the power take-off drives. The differential, the universal joints and the half-shafts are interchangeable between front and rear axle. Independent suspension of all four wheels by torsion bars and wishbone arms is provided. The torsion bars are interchangeable between all four wheels and each one can be removed without disturbing the rest. Telescopic dampers are fitted at the front and rear.

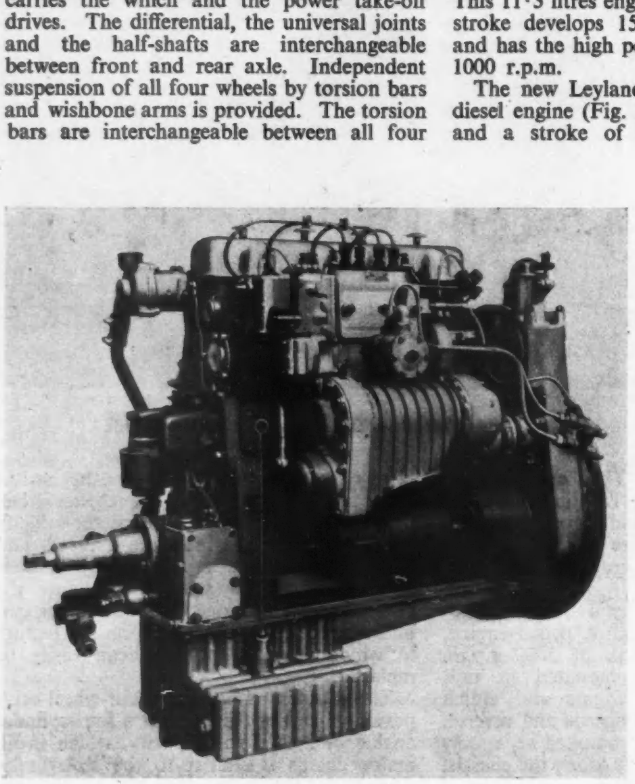


Fig. 12—Four-Cylinder, Two-Stroke, Diesel Engine—Foden

The bodywork is of all-steel, semi-integral construction with cutaway sides. A box-section cruciform chassis frame, the rear cross member of which takes the form of the rear body panel, incorporates reinforcements for the fitting of the winch gear. The floor front wheel arches, seat supports, rear floors, &c., are all welded to the main chassis frame and constitute the frame and floor assembly. The vehicle has a wheelbase of 7ft and a track of 4ft and its approximate unladen weight is 3500 lb.

Turning now to major vehicle components, apart from the exceptions previously noted, there appears to be no marked breakaway from orthodox design practice, nor any markedly new technical feature. There are, however, extensive detail modifications based on road experience, and alterations resulting from the adoption of advanced and more economical manufacturing methods. Such design modifications, self-evident as they are, generally pass quite unnoticed by the public, but they are just as essential to the quality of the final product as technical innovations.

As far as engines are concerned, British manufacturers have refrained from following the Continental practice of raising the engine speed for the purpose of obtaining a higher output per unit of cylinder capacity. Long engine life between major overhauls and maximum fuel consumption apparently is considered of more importance than any possible saving of bulk and weight, a policy which is entirely justified as long as the accommodation of the engine in the chassis—particularly that of underfloor engines—does not offer any major difficulties.

A deviation from the speed of 1800 r.p.m., which is almost standard in the heavier types of oil engines, is to be found in the new Thornycroft six-cylinder diesel engine. This 11·3 litres engine of 4¾in bore and 6½in stroke develops 155 b.h.p. at 2000 r.p.m. and has the high peak torque of 508 lb-ft at 1000 r.p.m.

The new Leyland horizontal, six-cylinder diesel engine (Fig. 10) has a bore of 3·96in and a stroke of 4·75in. With a cubic capacity of 5·76 litres it develops 90 b.h.p. at 2200 r.p.m. and has its maximum torque of 240 lb-ft at 1300 r.p.m. Like all the other Leyland oil engines, it has a toroidal combustion chamber recessed in the piston crown. Injection takes place through multi-hole injectors and a rotary air swirl in the combustion chamber is induced by means of a lip-like protrusion on the interior surface of the valve porting. The injection pump is of Simms manufacture, with a pneumatic governor operated by vacuum from the inlet venturi of the manifold. An interesting feature of this engine is an automatic advance mechanism giving optimum timing for fuel injection. This unit, which operates on the bob-weight principle, is located in the drive from the train of helical gears from the crankshaft to the fuel pump.

Care has been taken to make all the auxiliaries easily accessible. The filters for fuel and lubricating oil are mounted externally on the left-hand side of the engine, the compressor for the pressure brakes is at the front left-hand side and the injection pump is mounted on top of the engine amidships at an angle of 15 deg. from the horizontal.

Another new underfloor engine is the Perkins horizontal "P4V" (Fig. 11), developed from and having the same dimensions as the vertical "P4V" engine.

The conversion from the vertical to the horizontal unit was comparatively simple as the casting of the cylinder block of the original "P4V" included the flanges and bosses necessary for effecting this modification. It necessitated, of course, a new sump and some further alterations to the oil pump, the breathing system and to the drive of the injection pump.

The principal dimensions of this new engine are as follows: bore and stroke are the same as in the vertical model, namely, 3½in and 5in, respectively (swept volume 3·14 litres), and its weight, inclusive of all electrical components, is 700 lb. It develops its maximum of 52 b.h.p. at 2400 r.p.m., with a maximum torque of 133 lb-ft. It is important to note that no part of this horizontal engine is more than 8½in below the centre line of the crankshaft.

Apart from the four-cylinder horizontal unit, a vertical three-cylinder engine of the same cylinder bore and stroke has been developed by F. Perkins Ltd.; it forms the power unit of the new "Trojan" 15/20 van (intended for loads up to 20 cwt), the first British vehicle of this size ever fitted with a diesel engine. The engine has a capacity of 2·36 litres and develops 34 b.h.p. at 2200 r.p.m.; the weight complete with electrical equipment is 620 lb. A three-cylinder, four-stroke engine with its out-of-balance couple has, of course, a certain amount of vibration, but with suitable mountings and at the comparatively low engine speed it should not cause any appreciable disadvantage.

The new Foden "FD.4" oil engine is a four-cylinder version of the "FD." series of two-stroke engines and in its general layout and in the majority of its details, is similar to the "FD.6." The engine (Fig. 12) employs the uni-flow scavenging system and by appropriate valve areas and valve timing, utilises the kinetic energy of the exhaust gases for the purpose of reducing the scavenging pressure. The tangential inlet ports are arranged at the bottom of the cylinder liner and the exhaust valves in the cast iron cylinder-head are operated by rockers and short push-rods from a high camshaft. Although light in weight, the engine is of robust construction, the crankcase and cylinder block being a single aluminium alloy casting with cast iron wet liners. The crankshaft is of nickel steel, the five main bearings being of 3in diameter and the crank-pins 2¾in diameter, all running in steel-backed white metal. The pistons are of cast iron with 1⅝in diameter nitrided steel gudgeon pins. All timing gears are profile ground helical gears located at the flywheel end of the engine. The scavenging pump is a Rootes blower and the injection pump, complete with hydraulic governor, fuel-lift pump, and built-in filter, is mounted as a self-contained unit on top of the blower. The engine, of 85mm bore and 120mm stroke, has a capacity of 2·72 litres and develops 84 b.h.p. at 2000 r.p.m. with a torque peak of 235 lb-ft at 1500 r.p.m.

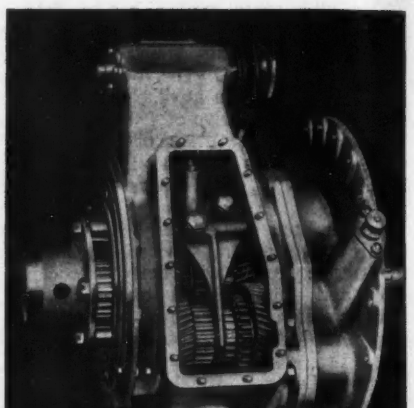


Fig. 13—9-Speed Epicyclic Gearbox—Foden

Like the Perkins three-cylinder, four-stroke engine, the four-cylinder, two-stroke Foden engine is not completely balanced, but here again at the moderate maximum engine speed of 2000 r.p.m., the vibrations caused by the out-of-balance couple should not cause any major inconvenience.

No major deviations from orthodox design practice are to be observed on petrol engines, apart from an ingenious detail on the engines of the "Big Bedford," made by Vauxhall Motors, Ltd. In order to prevent the exhaust valve, when closed, from taking up always the same position relative to its seat, a

steel cup has been interposed between rocker and valve stem. During the valve lift the inertia of the valve causes the valve stem to lose contact with the cup for a very brief period, thus transferring the pressure of the rocker through the cup temporarily to the spring retainer. The valve, relieved from its spring loading, is then free to follow the rotational swirl induced by the flow of the exhaust gases ; it has the tendency of rotating slowly about its own axis and taking up a slightly different position on its seat when closed. This new device has proved so successful in extending the life of the valve seats that the previously fitted inserted valve seats have now been dispensed with.

The development of transmission units as clutches, universal joints and propeller shafts has remained more or less static. These components are mostly proprietary products, developed to such a degree that modifications are confined to minor details only.

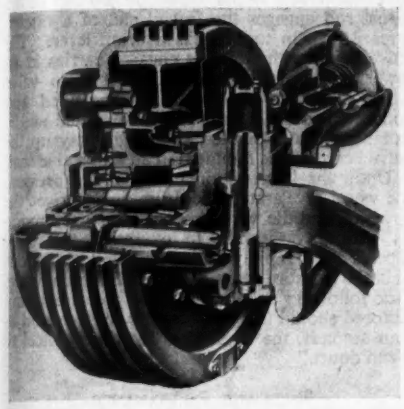


Fig. 14—Brake on "Tiger Cub"—Leyland

Borg and Beck Ltd., shows a new strap-drive clutch, exhibited in the 12in and 13in sizes, in which the torque from the cover pressing to the pressure plate is transmitted by means of four pairs of tempered steel straps. One end of each pair of straps is riveted to the cover flange, while the other end is bolted to the pressure plate. The straps are arranged in tangential position and can deflect when the clutch is released without interfering with the concentric position of the pressure plate. The absence of rubbing contact between the pressure plate and the cover eliminates friction and noise.

In this connection it should be mentioned that the increasing use of underfloor engines has created a definite demand for remote control not only of clutch operation but also of engine throttle. Hydraulic devices, similar in principle to hydraulic brake cylinders, are likely to replace the long and cumbersome mechanical operating rods.

Gearboxes for heavy passenger vehicles operating in this country are mostly of the self-changing epicyclic kind, frequently operated by compressed air. In gearboxes for goods vehicles the use of constant-mesh helical gears in all but the lowest gears is becoming almost universal. A noticeable development is the increasing application of auxiliary gearboxes arranged at the rear of the main gearbox. An interesting example of this principle is an epicyclic auxiliary box built into the rear extension of the main gearbox at the Foden "FE 4/8" chassis, a combination which provides nine forward speeds (Fig. 13). The main gearbox has three speeds and the auxiliary box has a compound train of epicyclic gears, affording an overdrive, direct and reduction ratios to all three main gears. The main gears are engaged by dog clutches and so are the auxiliary gears, but the latter are spring-loaded and so provide a pre-selective action.

The same purpose, namely, that of increasing the number of available speeds without any alteration to the main gearbox, has been accomplished by Eaton Axles, Ltd., in a two-speed axle, which is now available for light and heavy-duty passenger vehicles. A new feature of this axle is that the epicyclic reduction gear, which formerly was brought into action by vacuum or air pressure, is now electrically operated by button control from the normal gear-shift lever. The Eaton two-speed axle is now standard equipment of the Leyland "Tiger Cub" chassis.

Concluding this short survey on transmissions, it may be noted that the worm-gear is still the most popular drive for the heavier passenger vehicles and multi-drive vehicles, while the hypoid gear is entering the field of the light and middle-weight passenger and goods vehicles.

A significant trend in the brake design is the increasing use of floating shoes instead of the conventional type with a fixed pivot. This development, however, seems to be confined to proprietary brakes and is being adopted only tentatively for heavy vehicles fitted with brakes of the chassis manufacturers's own design. In accordance with motor-car practice, most makers of brake equipment have concentrated on the two-leading-shoe brake, operated either hydraulically or mechanically by means of cams or expanders.

Servo-assistance is used for all vehicles extending about 6 tons gross weight ; in case of vehicles fitted with petrol engines the vacuum system is almost universal, while for oil engine vehicles, particularly those for export markets, the air-pressure brake seems to replace the vacuum-assisted brake. Another system which is becoming popular is the Lockheed full-hydraulic system, made by Automotive Products Company, Ltd., in which the fluid pressure is generated by a small seven-cylinder radial oil pump. Both the hydraulic and the compressed air system are eminently suitable for passenger vehicles as the pressure, stored in air receivers or in spring-loaded accumulators, respectively, can be used, apart from brake operation, for other functions as door, clutch and gear-change operation, engine throttle control and power-assisted steering.

Interesting, among various other exhibits at the stand of Clayton Vevandre Company, Ltd., were the latest type of direct-acting brake cylinders, which are mounted on to the brake back plate assembly. This design, though not novel, has the advantage of reducing the mechanical losses from the brake cylinder to the operating cam or expander to a minimum. A similar design, that of an air brake for the Leyland "Tiger Cub," was to be seen at the stand of Westinghouse Brake and Signal Company, Ltd. (Fig. 14). In place of the more usual piston operation, the brake camshfts here are diaphragm-operated through short push-rods and levers. This brake also incorporates Bendix-Westinghouse slack adjusters, which permit very accurate adjustment by means of a miniature worm drive between brake lever and camshaft.

It is regretted that lack of space does not allow even a short survey of the bodywork section, though a considerable number of exhibits in this section are excellent examples of both engineering skill and artistic design. Bodywork like the forty-one-seater coach of Thomas Harrington, Ltd., built of light-metal in integral construction, the integral forty-four-seater bus of Metropolitan-Cammel, Ltd., with structural members of high-grade steel and lightly stressed pillars, panelling, &c., of aluminium alloy and, further, the ingeniously constructed coach and bus bodies of Park Royal Vehicles, Ltd., and Saunders-Roe, Ltd., as illustrated in Fig. 15, deserve more than a cursory mention. They all fit well into the general pattern of this year's exhibition, which more than any of the past Commercial Motor Shows, emphasises the urgent need for greater economy in road transport and, at the same time, clearly demonstrates how by new conceptions in design many difficulties can be overcome. It is to be expected that this year's Show, which in practically every respect is most satisfying from the engineer's point of view, will convince all visitors, in particular those from overseas, of the high quality of British commercial vehicles.

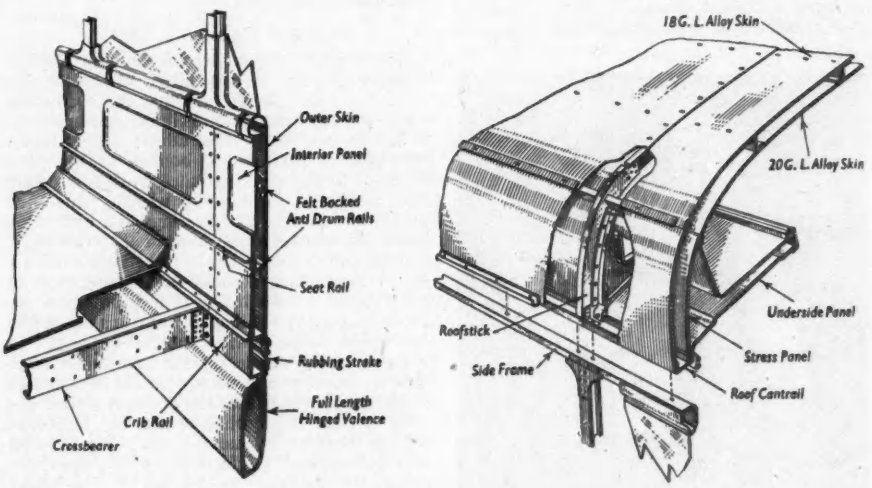


Fig. 15—Examples of Side and Roof Construction—Saunders-Roe

SWEDEN'S POWER PLANTS.—It is reported from Stockholm that new electricity generating plant with a total capacity of 248MW was completed in Sweden in 1951. The corresponding figure for this year is expected to reach a record of 340MW, of which 200MW was available at the beginning of August.

Automatic Landing Wheel Braking

The adoption in the larger aircraft of bogie wheel undercarriage systems has led to the development of automatic braking units which provide for the optimum deceleration of the aircraft and compensate for the factors which induce wheel locking or skidding of individual units. Two systems are described.

SINCE the war certain of the larger military and civil aircraft have adopted some arrangement of multi-wheeled suspension systems. The primary dictate for this complication arose with the need to prevent further increases in runway loading per unit area with the increasing weight of these craft. Structural requirements associated with the stowage of such undercarriages stipulated smaller wheels requiring higher tyre pressures and consequently a greater number of wheels.

With such landing gear and higher landing speeds the problems of wheel braking without skidding were influenced by markedly different factors than those which applied to the single-wheel gear on earlier and slower landing aircraft, and particularly to those aircraft employing a tail wheel. Here the pilot and the aircraft itself were sufficiently sensitive to manual differential wheel braking whereby the pilot could immediately sense the degree of braking torque on each wheel and even hear as well as feel a skid. It was essential that he had this facility, as tail wheel aircraft were ever ready to deviate from the runway heading during the early critical stages of landing and at take-off, and carefully judged differential wheel braking was essential for the safety of the machine.

Although for that particular reason the need for this facility is much reduced with tricycle landing gear, without it the pilot, sitting well forward of the undercarriage, is now no longer able to sense tyre skidding, particularly amongst the individual wheels of a bogie design. He is therefore unable with safety to attempt to maintain optimum deceleration without fear of protracted or intermittent skidding of one or more of the tyres. For depending on aircraft inertia, the method of shock absorption, the bogie action when traversing uneven ground and upon cross

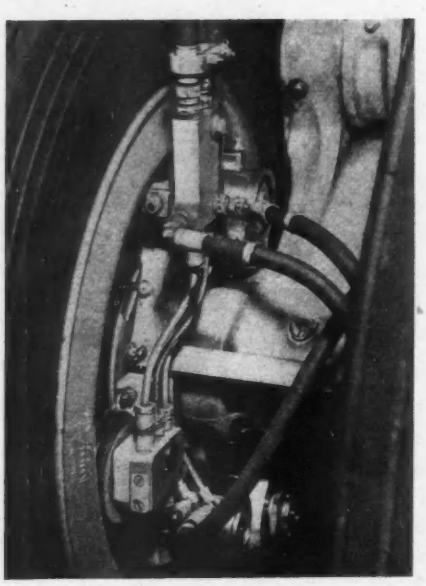


Fig. 1—" Maxaret " Installation on the " Comet "

wind landing conditions, loadings fluctuate between wheels on the same unit, and they may experience different ground coefficients. Against such factors it is virtually impossible, even were they sensed in the cockpit, to counteract them manually.

Tyre bursts on a locked wheel can occur within a four to five second period and it became imperative to incorporate within each independent unit of an articulated bogie an automatic braking unit which would maintain the optimum braking torque conducive to rolling without sliding against whatever skidding inducements prevailed.

The need is advanced also for its inclusion on high speed fighter aircraft. Although here the sensitivity factor is not involved, the high landing speed and need for early brake application cause particularly heavy damage to the tyre should it skid.

At the S.B.A.C. show we noted two installations for obtaining maximum braking torque without skidding. In each design is a flywheel driven through clutch mechanism from the landing

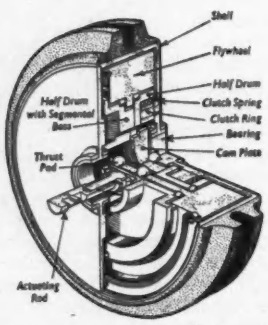


Fig. 2—Sectional View of Assembly

wheel and so arranged as to employ the relative motion between the flywheel and landing wheel to interrupt the brake fluid supply in the event of the peripheral speed of the tyre becoming less than the landing speed.

The " Maxaret " Unit

The system adopted by the Dunlop Rubber Company, Ltd., is that fitted amongst other aircraft to a " Comet " airliner for evaluation trials and that installation is illustrated herewith. It can be seen in our illustrations (Fig. 2) that a twin-contact rubber tyre bonded to the periphery of a steel shell is rotated by direct contact with a rim of the landing wheel. This shell rotates on uncaged ball bearings in a light alloy mounting bracket which is secured to the leg.

The shell houses a heavy rim flywheel with a single diametral spoke and within the flanges of the flywheel are the halves of a drum which are secured axially. Rolling between this drum and the flanges of the flywheel are ball bearings. In Fig. 3 details of this arrangement are shown more clearly, and it will be noted that the boss, which is carried by one-half of the drum, is slotted not only to clear the flywheel spoke, but to permit also a relative movement between the flywheel and the drum of 60 deg. Normally, the drum drives the flywheel by contact of the spoke with the bosses, and for the initial static case a main spring is arranged to pull the drum round to the flywheel. The clutch unit comprises a ring around which is arranged a closely wound wire spring, one end being anchored to the ring and the other is free. On the shell cover are two pegs on which the ring is located and it is housed within the flywheel drum so that the coil spring is in static contact with the inner ring. Drive is thus transmitted from the landing wheel through the shell cover and hence the pegs to the clutch ring. The winding of its spring is such that when the shell rotates the spring tends to expand and through its contact with the ring on the flywheel drum provides a positive drive to that member. This drum drives the flywheel through the segmental boss and spoke, and all four units attain the same rotational speed.

When conditions cause the landing wheel and the shell to decelerate above a rate which would induce skidding of the tyre, the drum is no longer driven by the clutch, but the flywheel, due to its inertia, is able to advance through 60 deg. against only the preset pull of the locating spring and the friction of the ball bearings on which it rides on the drum. This relative movement is employed to actuate the valve mechanism and interrupt the brake action.

On the centre of the drum is keyed a cylindrical cam block which has a broad and shallow diametral V profile cut into the face in line with the normal direction of the flywheel spoke. In this spoke are two balls in diametrically opposed clearance holes, which register with the bottom of the V groove. Consequently, any relative motion of the flywheel with respect to the drum carries the balls up the sides of the channel, displaces them axially in the spoke, and causes a sliding thrust pad with which they are in contact to actuate a rod communicating with the valve lever.

The valve mechanism is housed jointly in a box bolted to the mounting bracket and within that unit itself. A pin shown on the end of the thrust rod engages the forked end of a ratchet lever which, in turn, rocks a beam lever. The valve beam with which it engages carries at its lower end a radially drilled inlet slide valve which slides in a sleeve similarly drilled and connected to the pressure line. A fluted needle exhaust valve is pivoted about half way up the valve beam and is mounted in an adjustable seat.

Upon the interruption of the brake pressure the wheel accelerates, the drum again drives the flywheel, and the valve mechanism is restored to its neutral position. In operation the cycle repeats itself rapidly and only small reductions in brake pressure actually occur. Should a wheel lock following a bounce, brake pressure is not restored should this be necessary for a period of four seconds, the time taken for the flywheel to " run down."

Tests and Performance

Initial tests of the unit were carried out with a small aircraft wheel and brake unit, with which simulated landings were made on the rotating drum of an inertia test machine. Arrangements were made to record wheel speed and brake pressure against a time base. The recordings made of some 200 tests proved the unit to be working well within the design requirements. Pressure response was found to be as rapid as 7 c/s for the small wheel and brake unit of low fluid capacity. As the test was extended to include units of larger capacity the pressure-time curve resolved into a smooth line. This, being accompanied by a correspondingly smoother wheel speed time curve, indicated that the longer response time of the larger brake units allows the wheel to resume the datum

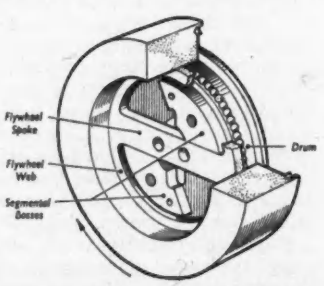


Fig. 3—Details of Segmental Bosses

angular velocity accompanied by smaller drop in the brake operating pressure. To reproduce conditions present in large aircraft the exhaust from the " Maxaret " unit was made to discharge through a head of 25ft without appreciable effect upon the performance.

For flight trials a pair of units were installed in a twin-engine aircraft of 8000 lb all-up weight, and having a tricycle undercarriage. Dunlop two-plate brake units of medium-low capacity were used, and tests carried out at operating pressures varying from 1000 lb to 1500 lb per square inch. Facsimiles of three test recordings under " Maxaret " control (Fig. 4) are reproduced.

Landing (*a*) is on tarmac with wet patches.

touch down occurring at 92 m.p.h., brakes on at 85 m.p.h., braking time 11·6 sec, mean deceleration 0·33 g. Landing (*b*) is on wet grass, touch down occurring at 80 m.p.h., brakes on 72 m.p.h., braking time 14 sec, mean acceleration 0·23 g. Brake pressures were 1500 lb per square inch. The third set of curves (*c*) were electronically recorded in the laboratory and are for a small aircraft wheel running on a smooth, dry steel drum.

This unit may be installed on conventional hydraulic brake systems with only slight modification to the piping itself. The obvious requirement is the provision of a driving flange on the landing wheel at a suitable radius. As the ratio of the landing speed of the aircraft to the peripheral speed of the flywheel shell are directly proportional to the ratio of the landing wheel

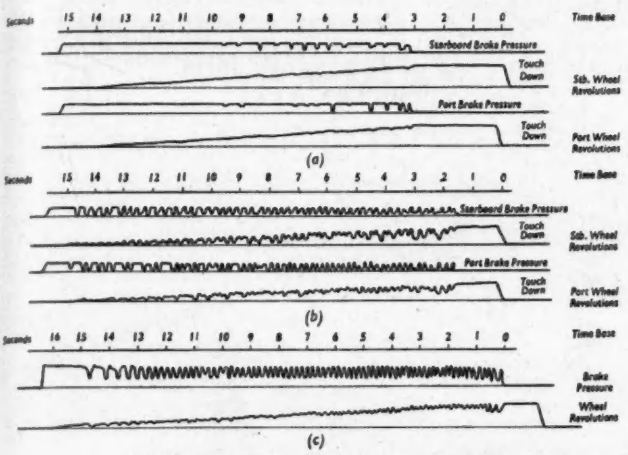


Fig. 4—Recorded Performances of "Maxaret" Unit

radius R and the radius of the driving flange r providing that $\frac{r}{R}$ is kept between 0·475 and 0·650, the necessity for varying the datum setting of units or of providing various ranges of units according to wheel sizes and landing speeds does not arise. The only considerations which call for slight differences are those of wheel and brake unit handing and direction of rotation.

The company states that the method of drive chosen entails negligible wear or slip and its resilience absorbs any effect of manufacturing tolerances in the wheel or of possible axle deflections at peak loads. Sensitivity in the unit is assisted by the use of frictionless bearings and ball contacts. The unit is very light and compact, measures 4½in by 3¾in by 2½in overall, and weighs 4 lb 10 oz. It can be employed with brake pressures up to 2500 lb per square inch and has a temperature range of −40 deg. Cent. to +70 deg. Cent.

The "Decelostat" Unit

The braking unit displayed by the Westinghouse Brake and Signal Company, Ltd., was originally developed by the Westinghouse Air Brake Company in America, and was described in a paper read before the S.A.E. in October, 1949, from which the illustrations have been reproduced. The "Decelostat" is fitted to several military aircraft in America and in this country is undergoing evaluation on a "Vampire" aircraft. It consists of a stationary valve unit and a rotating assembly, this latter being normally positioned on the outboard centre of each landing wheel and rotates directly with it. The valve unit being fastened to some stationary point, is connected to the rotating assembly by the lever F shown in Fig. 5. Amongst the main components of this assembly are the clutch spring L, bearing ring N, clutch P, ring gear Q, washer R, and front housing K, all of which will tend to rotate together as the landing wheel gathers speed. At the instant of touch down, however, the flywheel X is at rest and consequently the idler gears rotate about the sun pinion, which is integral with the flywheel and hence carry the spider and shaft T to the extent of the travel permitted by the lever arm V and operating lever F, and against the acceleration rate setting of the valve spring C. At the same time, during the initial high rate of wheel acceleration, the ring gear is designed to slip between the washer R and the clutch, meanwhile accelerating the flywheel through the gear ratio of 7 : 1. At the instant the flywheel attains full speed the graduating spring C is able to thrust the operating lever back to its neutral position, the other rotating parts all having the same speed as the landing wheel, with the spider and its shaft stationary. In this position the pilot valve E becomes seated and the fluid pressure will equalise on both sides of the piston through the orifice W. The piston spring is then able to thrust the piston to its upper position, thus sealing the exhaust port and opening the delivery port. As long as the operating lever is in the neutral position the pilot valve remains seated by its spring and fluid pressure, and the wheels will be under maximum braking torque.

Upon the onset of a change in the rate of deceleration of the landing wheel, and hence the ring gear, the flywheel, due to its high inertia, will tend to drive the idlers and again cause the spider to rotate to the limit of its travel with the levers. This action unseats the pilot valve and the unbalanced fluid pressures about the piston, thus causing it to be forced downwards, blocking the supply port and opening the delivery to exhaust. Release of the brake pressure will quickly enable the landing wheel to accelerate, the ring gear will again be turning the flywheel, and the change in the torque reaction will cause the spider to revert to the other limit of its travel, the pilot valve remaining unseated. Once the flywheel attains full speed again the operating lever is instantly returned to the neutral position, the pilot valve is seated, and pressure fluid is again able to pass to the brakes. It will be seen from the performance curves we reproduce that the cycle described is repeated so rapidly that only a relatively small reduction in brake pressure actually occurs.

In order absolutely to minimise the time required to obtain full brake (Fig. 6) after the airplane wheel has attained normal speed, the clutch arrangement as shown in detail in Fig. 5 has been included.

The latch cover H to which is attached the latch J is secured to the housing. This latch will engage with the clutch which rides between the bearing ring and the ring gear, which, in turn, rides on the washer R, which acts merely as a wearing plate and may be considered integral with the housing. As the landing wheel begins to slide, the ring gear will be driven counterclockwise by the inertia wheel as previously explained. The clutch is free to rotate in this direction on the bearing ring and will be carried with the ring gear which will slide over only the washer R; thus, the flywheel can drive the ring gear against only one friction element. Therefore the energy extracted from the inertia wheel during a slip or slide is reduced to the minimum necessary to operate the valve plus a reasonable margin. As the wheel picks up again, however, the ring gear (which attempts to remain stationary due to its connection to the inertia wheel, which we will assume is completely stopped) will be picked up by friction of the clutch on one side which is turned in this direction with the housing through the latch and the washer R on its opposite side, thus imposing two friction elements to aid in bringing it up to speed. By this means the rate of acceleration of the inertia wheel will be twice that of deceleration. This will allow brake pressure to apply more closely to the time the wheel reaches normal speed.

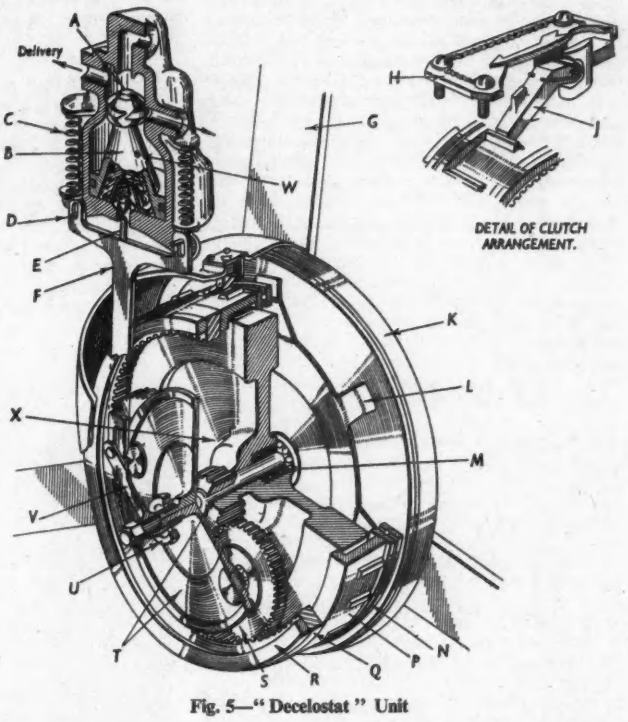


Fig. 5—"Decelostat" Unit

Tests

These units are adaptable to either hydraulic or pneumatic installations. To date, tests have been conducted with both systems. Pneumatic installations such as described covered both expander tube and spot disc types. Hydraulic tests applied to laboratory equipment were also conducted. The unit has been modified in certain details from that illustrated. In curren designs the operating levers are taken from the stub axle on the opposite side of the wheel to that shown.

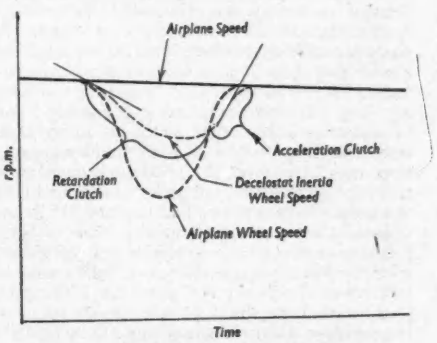
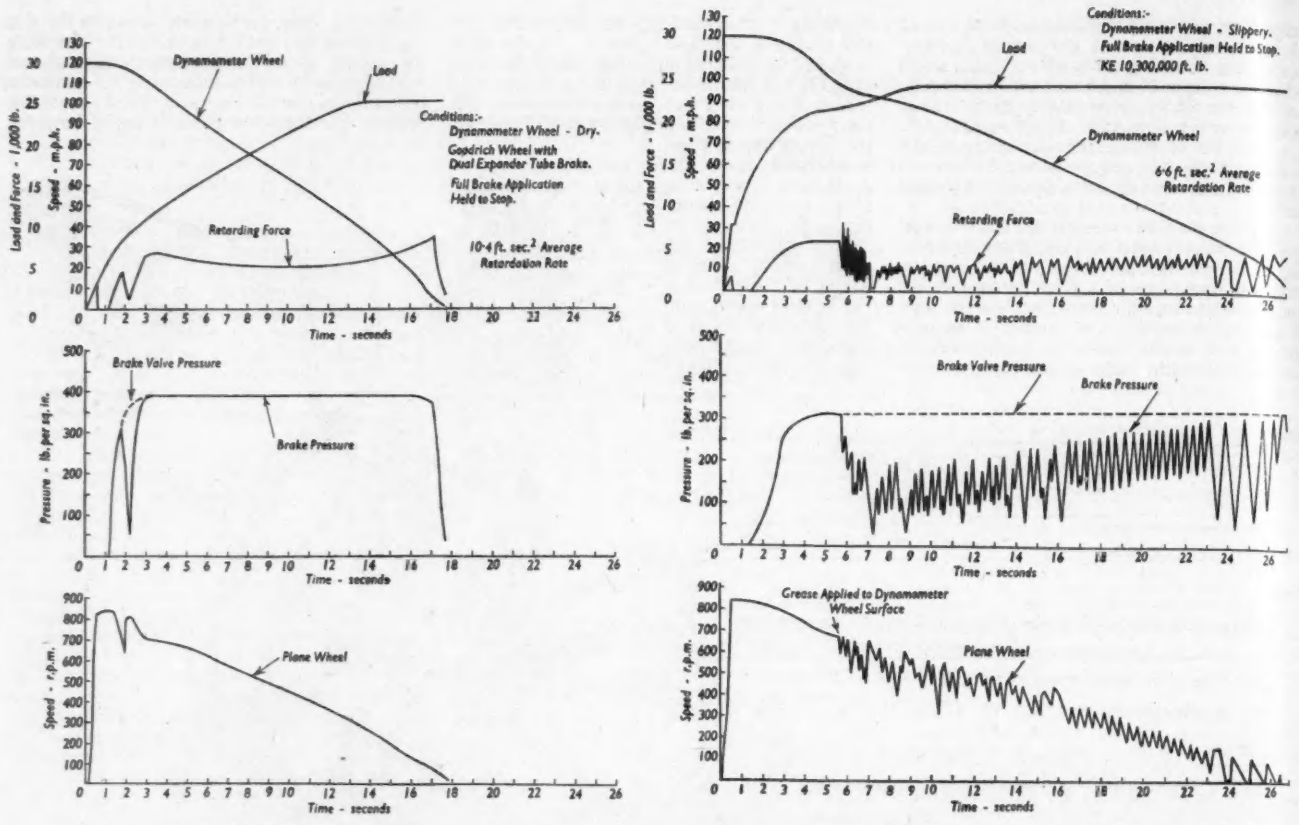


Fig. 6—Characteristics of "Decelostat"

At Wright Field, America, the unit was applied to a dynamometer wheel, which develops a kinetic energy of 10,300,000ft-lb at 120 m.p.h. landing surface speed. The landing wheel used



CHARACTERISTIC CURVES DURING STOP FROM 120 M.P.H., 400 LB./SQ. IN. BRAKING PRESSURE.

CHARACTERISTIC CURVES DURING STOP FROM 120 M.P.H., 300 LB./SQ. IN. BRAKING PRESSURE.

Fig. 7—Characteristic Performance Curves of "Decelostat"

was a Goodrich 18·00–20 wheel with dual expander tube type of brake. A pneumatic brake system was used with the appropriate pneumatic brake valve, relay and valve. A 1500 lb per square inch supply system was employed with a maximum of 400 lb per square inch brake pressure applied through a metering brake valve. This was deemed to be maximum pressure for that particular type of brake. Load to the wheel was applied in a manner to duplicate that of a landing with an airplane which would reach a final load of 25,000 lb on the wheel. Approximately normal loading tests were run which reached maximum load in 11 to 15 seconds abnormal 23 to 25 seconds; eighty tests were run, of which two (Fig. 7) were selected as being representative of the performance. These tests were run at 120 m.p.h. landing speed. A good runway condition was simulated by braking against the dry steel dynamometer wheel. A slippery condition was then simulated by applying liberal quantities of grease to the steel dynamometer disc. The tests were purposely made by applying full brake pressure and holding it on to the stop in order to reach as many slide conditions as possible. During the dry runway stop the "Decelostat" functioned once at a point 0·6 second after the brake was applied. At this point brake pressure had reached 315 lb per square inch, and the wheel was loaded at 8000 lb, the wheel had started into a slide at 0·25 second after brake application from a full speed of 840 r.p.m. (122 m.p.h.), reaching 710 r.p.m. (103 m.p.h.) at the time the brake released. Pressure was then reduced from 315 lb to 55 lb per square inch in 0·4 second, during which time the wheel speed reduced to a "low" of 630 r.p.m. (91·5 m.p.h.). The release of brake pressure was effective in 0·1 second to start the wheel up to speed again and reached 810 r.p.m. (118 m.p.h.), 0·2 second after it started to pick up. The braking was normal from this point and the stop was accomplished in 17·7 seconds with an average retardation rate of 10·4ft per second per second (7·08 m.p.h. per second per second).

The grease run was made by introducing a liberal amount of grease between the wheel and dynamometer surface after the wheel had been brought up to speed and a brake pressure of 310 lb per square inch established. At the point the grease was applied, the airplane wheel was rotating at a speed of 670 r.p.m. (97·5 m.p.h.), loaded to 21,500 lb, increasing during the stop to a total of 24,300 lb from the point of grease application; sixty-one "Decelostat" releases occurred in a period of 21·1 seconds. This resulted in an average retardation rate of 6·6ft per second per second (4·9 m.p.h. per second per second.)

These tests revealed that with a dry runway condition under comparatively light wheel loading (5000 lb) the wheel started to pick up after a slip on approximately 50 lb to 75 lb per square inch pressure drop and was fully recovered on a 100 lb to 150 lb per square inch drop in initial brake pressure. The wheel recovered at a rate of 294ft per second per second (200 m.p.h. per second per second). Under slippery conditions, however, brake pressure had to be reduced to 100 lb per square inch or below before the wheel started to recover. The minimum rate of recovery under slippery conditions was 88·1ft to 103ft per second per second (60 to 70 m.p.h. per second per second). Final tuning of the unit to reach the optimum setting for both slippery and dry conditions resulted in a dry runway stop from 120 m.p.h., 400 lb per square inch brake pressure with an overall deceleration rate of 11·1ft per second per second (7·55 m.p.h. per second per second), showing three releases during the stop. Average adhesion values varied from 59·5 per cent for dry runway to 17 per cent under slippery conditions.

Electricity Consumption in Britain

STATISTICS published recently by the British Electricity Authority show that the downward trend of electricity consumption continued during August. The number of units sold by the Authority was 3631 million in August, 1952, which was 2·8 per cent less than in August, 1951; but allowing for weather conditions and the number of working days, the adjusted figure was 0·7 per cent below the August, 1951, level.

Despite the overall drop, six of the fourteen Area Boards were able to record increases in August, 1952, compared with August, 1951. The Southern Area Board showed an increase of 4·5 per cent, partly due to the load created by the Fawley oil refinery; other increases were 3·8 per cent by the South Western Board, 2·5 per cent by the South Eastern Board, 2·4 per cent by the Eastern Board, and 0·9 per cent by the South East Scotland Board. A small increase of 0·7 per cent was achieved by the South Wales Board; but is is clear that the effect of the Margam and Trostre steel works upon the monthly consumption is becoming progressively less noticeable. Thus, for the twelve months ending August 31, 1952, there was an increase of 8·2 per cent compared with the previous twelve months; whereas in the first five months of the financial year, 1952–3, the increase was only 6·2 per cent, compared with the corresponding period of 1951–2.

Turning to those Area Boards which experienced reduced sales, we find that in Merseyside and North Wales there was a fall of 9·6 per cent in August, 1952, compared with August, 1951. This drop is due, in part, to reduction of energy interchange following the extension of some large private generating plants operated in conjunction with the public supply. Similar factors were at work in the North Eastern Area, where the sales of electricity in August, 1952, were 9·4 per cent less than in August, 1951. In the North Western Area there was an increase of 1·6 per cent in the twelve months total up to August, 1952, due mainly to a large new industrial load, but the monthly figure for August, 1952, was 12·9 per cent below the corresponding figure for August, 1951. Applying the same monthly comparison to other Area Boards, we find that there were drops of 0·4 per cent in London, 1·6 per cent in the East Midlands, 2·6 per cent in the Midlands, 0·2 per cent in Yorkshire and 3·7 per cent in South West Scotland.

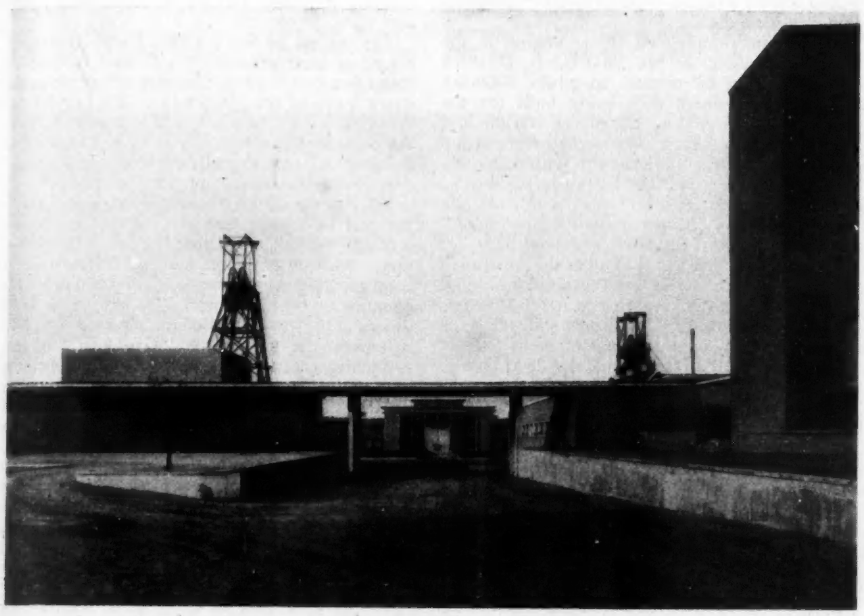
WORK STUDY FOR SUPERVISORY MANAGEMENT.—The Institute of Industrial Supervisors is arranging a week-end residential course for foremen and supervisors at Ashorne Hill, Leamington Spa, from November 21st to 23rd. The course, the theme of which is "Work Study for Supervisory Management," will be conducted by Mr. Geoffrey P. Wade, A.M.I.E.E., and Mr. Victor N. Picken, A.M.I.E.E., of the department of industrial administration, Birmingham College of Technology. Details of the course are available from the Institute of Industrial Supervisors, Bank Chambers, 47, Temple Row, Birmingham, 2.

Calverton Colliery

At Calverton, some 7 miles north of Nottingham, the first large colliery to be constructed since the nationalisation of the coal mines in this country is now almost completed. This colliery will eventually have an output of 1¼ million tons of coal a year, and to serve it a new railway line 7 miles long was constructed by British Railways.

CALVERTON colliery, the first large, new colliery to come into production since the mines of this country were nationalised, was officially opened on Wednesday, September 24th. This colliery is some 7 miles north of Nottingham and for the transport of the coal it produces a new double-track branch line has been built by British Railways, together with an extensive system of sidings.

The sinking of the new colliery was originally planned by B.A. Collieries, Ltd., and work on sinking the first shaft was started in June, 1937. This shaft was completed in November, 1939, when it reached the Top Hard seam connection which had been made from the company's Bestwood colliery, some distance away. Coal from this Top Hard seam continued to be mined at Bestwood, and the new shaft was used for riding men to the seam and for ventilation purposes. By September, 1939, the canteen, pithead baths, lamp-room and offices had been built, but then work was stopped owing to the outbreak of the war. In 1945 the original plans were reviewed and it was decided to sink a second larger shaft, which would be equipped for skip winding, together with the latest equipment for coal handling and preparation.



Colliery Approach Road and Surface Buildings

Aerial View of Colliery and Coal Preparation Plant

In laying out the new colliery and its buildings every effort has been made to preserve the amenities and appearance of the surrounding countryside. Following visits to collieries in this country, on the Continent and in the United States, an effort has been made to incorporate all the best features of the designs adopted in other places, combined with an efficient working layout. All of the surface buildings which have been, or are to be, constructed, have been designed by an architect in consultation with the engineers. The buildings have flat roofs and concrete copings and with their clean lines bear but little resemblance to the generally accepted appearance of a coal mine in this country. A concrete canopy spans the entrance roadway and connects the pithead baths and offices, whilst the lamp-room and time-keeping offices form a continuation of the baths' building and lead to a passageway to the winding shaft. This arrangement of the buildings afford workmen protection from the weather. A 5ft square underground duct beneath all the main buildings carries all the service pipelines, power cables, &c., which are usually carried overhead.

Investigations have shown that the colliery has the following seams of coal: High Main, 386 yards; Main Bright, 463 yards; High Hazel, 483 yards; Low Hazel, 508 yards, and Top Hard, 560 yards; and its calculated reserves, with an output of 1¼ million tons output a year, will last for about a hundred years. The first seam to be worked will be the High Main and at present three longwall faces have been opened for production. These faces are being cut mechanically and the coal is hand-loaded on to belt conveyors for transport to a 600-ton capacity underground bunker. From this bunker coal will be discharged by a regulating feeder into 10-ton skips for haulage to the surface, when the installation is completed in a few months' time.

The No. 1 shaft, sunk before the war, is 18ft 2in diameter and is connected with the Top Hard seam at a depth of 560 yards. The cementation process was used in its construction, water being encountered at a depth of about 20 yards and extending down to 120 yards. A lining of 18in of reinforced concrete surrounds the bore through the water bearing strata and this lining is reduced to a thickness of 14in below that level. When the new No. 2 shaft was sunk it was decided to use the freezing process, and this 560 yards deep, 20ft 2in diameter shaft is lined with concrete in the dry measures and cast iron tubbing through the water-bearing strata. Its sinking was completed in July, 1952 (see THE ENGINEER, September 23, 1949).

When the colliery is in full operation the coal will be wound by the 10-ton skips in the No. 2 shaft at a rate of 400 tons an hour. This skipping installation was supplied by Head, Wrightson and Co., Ltd., and the headgear by Plowright Bros., Ltd. From the pithead the coal will be conveyed by a belt to a coal preparation plant to be seen in the aerial photograph of the colliery that we reproduce on this page. One corner of the pithead building can be seen on the extreme right in this illustration. The transfer conveyor belt runs underground and through a chamber built within a bridge over a road between the pithead and the preparation plant. Waste from the mine will be wound from the No. 1 shaft and taken on a belt conveyor system to a valley to the north-east of the preparation plant, where it will be disposed of unobtrusively. The site of the waste dump is hidden from the road and will be planted with trees.

The coal preparation plant, which is being supplied by Colliery Engineering, Ltd., is still in course of construction but its initial handling section is already partly in operation. When completed the plant will handle 450 tons of coal an hour. Coal delivered from the pit-head by the conveyor belt is screened, the grades below 8in passing to hoppers for treatment in the washing plant, and those above 8in passing to a 31ft diameter rotary picking table. The smaller grades of coal, from 8in to 1in, will eventually be dealt with in a "Barvoys" washer

and those below 1in will be treated in " Blantyre " Baum wash-boxes. The arrangements are such that the grades of 8in and below which by-pass the picking table can be either washed or handled in the dry state. On the annular picking table, where the grades of over 8in are deposited, any stone is pushed by operators to the outside edge, where it is ploughed off as the table rotates and falls down a chute on to a conveyor belt leading to the disposal point.

The preparation plant is built over eight wagon roads, on which the wagons are automatically positioned below loading chutes by a mechanical device on each track. Arms on these devices are controlled by switches in the preparation plant above, and they contact the wagon-axles and propel the wagons forward in turn into the required position below the chutes. The plant is designed to handle and load the 24½ ton mineral wagons now being used on British Railways.

The whole of the colliery surface and underground workings are fed by electrical power from the national grid and a large substation has been built at the colliery.

The new double-track branch railway line connects the colliery to the former London, Midland and Scottish and North-Eastern Leen Valley lines near Bulwell, the connections being at Bestwood Park Junction and Calverton Branch Junction. The connecting lines converge at Papplewick Junction and then run eastwards to the colliery. The branch from Bestwood Park Junction to its connection with the colliery sidings north of the coal preparation plant is 7 miles, 12 chains long, and the section between Calverton Branch Junction and Papplewick Junction is 37 chains long. In the construction of this new branch line and its associated sidings more than a million cubic yards of spoil has been moved and 34,000 yards of plain track and 3100 yards of points and crossings have been laid. The connections it provides with the two Leen Valley lines will enable coal to be dispatched to all parts of the country. The sidings, which were designed to fit into the general contours of the land, have a capacity of 1000 full and 770 empty wagons. Diesel locomotives used to handle the wagons in the sidings will be in short wave radio communication with the full weigh office to reduce time loss in wagon movement.

The new lines called for the construction of five new underbridges and four new overbridges. Three of the underbridges, one of 10ft span, a second of 12ft span and a third of 20ft span, are of similar construction with mass concrete abutments and wings supporting precast reinforced concrete slabs. The slabs were manufactured in the concrete depot at Newton Heath and erected in advance of the embankment from the ground.

The fourth underbridge over a public road (Moor Lane) has a square span of 40ft and a skew span of 68ft. Its mass concrete abutments and wings support two independent spans consisting of welded plate girders, steel floor beams and an *in situ* concrete deck. The fifth underbridge has a square span of 53ft and is similar in design to Moor Lane bridge.

Two of the overbridges, each of which is 14ft wide, are three-span structures erected *in situ*. The main overbridge is at Mansfield Road, which carries very heavy traffic. The road was diverted to pass over the new bridge, which is 60ft wide with a square span of 27ft. Mass concrete abutments and wings support an *in situ* reinforced concrete deck.

The fourth overbridge carries Papplewick Lane and has a width of 35ft and a skew span of 49ft. Its mass concrete abutments and wings are constructed in trenches cut out of the sandstone and its deck is formed of welded steel girders with an *in situ* reinforced concrete floor. All of these bridges are designed so that any future lifting necessitated by subsidence can be easily carried out. They are provided with jacking pockets and the up and down tracks are carried on separate structures.

Four new signal-boxes have been installed at Bestwood Park Junction, Calverton Branch Junction, Papplewick Junction and at Calverton Colliery.

Diesel Engine Construction in Australia

THERE has just been completed by the Commonwealth Government Marine Engine Works, Port Melbourne, the first large marine diesel engine to be built in Australia. The Port Melbourne works—together with another Commonwealth Marine Engine Works at Brisbane—was established in the early years of World War II to build main and auxiliary engines for naval and other ships under construction in Australian yards. The Brisbane plant, after turning out a number of large and small marine engines, was taken over by the English Electric Company, Ltd., but during the war, and since, the Port of Melbourne works built triple expansion engines with exhaust turbines, of both 4100 and 3100 shaft h.p., double compound engines of 1850 shaft h.p., engines for frigates, high-speed engines of 50 h.p., steering engines and 5-ton cargo winches. With this sound background of steam engine experience, the Port Melbourne works, which is now controlled by the Department of Defence Production, was in a good position to undertake the construction of large diesels.

The recently-completed diesel engine is the first of an order for six 2800 b.h.p. Doxford opposed piston oil engines to power 6000-ton " B "-class freighters now being built for the Australian Shipbuilding Board for coastal and island trading. The remaining five engines are expected to be completed at approximately six-monthly intervals. The licence to build these patented opposed piston oil engines in Australia was bought by the Commonwealth Government in 1948 from William Doxford and Sons, of Sunderland, England, as a result of the Australian Shipbuilding Board's decision to build a number of coastal freighter motorships of 6000 tons deadweight capacity. With the licence, the Commonwealth acquired a complete set of drawings for the four-cylinder, 2800 b.h.p. engine, plus the right to send engineers to the Doxford works to investigate special techniques in building the engine.

The Doxford engine, like most marine diesels, is dimensioned in millimetres, and the first job which had to be tackled was the redrawing of every one of the many components. Another problem for the Port Melbourne works was set by the tolerances for all important dimensions. Doxford machinists knew from experience dating back to 1918, what tolerances to allow, but this information was not on the drawings. Because of the large number of components, some sub-assemblies were sub-contracted to other Government factories. All the fabrication of frame members, the machining and assembly of the cylinder liners and jackets, the machining of piston heads and forging of the motion-work components were carried out by the Ordnance Factory, Maribyrnong, Victoria. The only components indented from the United Kingdom were some crankshaft forgings and special instruments. As the assembly of each engine is completed at Port Melbourne, it will be given a thorough test run. A well-equipped test house has been built alongside the assembly bay to accommodate the auxiliary equipment necessary to run the engines on full load.

An Oil Terminal at Port Kembla, N.S.W.

UNTIL comparatively recently, the fuels normally used in Australian open-hearth steel furnaces were gas and tar, both by-products of the coke ovens. Furnace oil is, however, now used to supplement tar up to 50 per cent of the quantity required, and during 1951 the Kembla works of Australian Iron and Steel, Ltd., used nearly 1 million gallons to fire their open hearth furnaces. A permanent source of supply of fuel to the Kembla works has now been assured by the opening of a new bulk oil terminal at Port Kembla this year. It was erected by the Vacuum Oil Company, Pty., Ltd., at a cost of some £90,000 on eight acres of land in the vicinity of the Port, and was the first of its kind to be built by the company, and the twentieth ocean terminal to be placed in service by Vacuum. When performing the official opening ceremony, the Hon. W. Davies, Member of the House of Representatives, referred to the installation as another step forward in the development and progress of the district which, he added, is destined to become the largest industrial centre in the Southern Hemisphere. By providing a permanent additional source of heat for the open-hearth furnaces, the new terminal will increase production and enable a continuous flow of metal to be delivered to the hot and cold strip mill now under construction.

The furnace fuel oil being used by A.I.S. is produced at Palembang, in Sumatra. This oil is one of the few available in the world to-day with a sulphur content low enough to enable it to be used for the manufacture of steel. Freedom from sulphur is fundamentally important, but it is also necessary that the fuel used in open-hearth furnaces should have particular flame characteristics. Vacuum has been able to achieve this essential combination at Palembang refinery and, with such a source of supply only 1800 miles from Australia, the company is in a position to supply furnace oil at an economical cost.

The tankers serving the Port Kembla terminal discharge their cargoes of hot, fluid furnace oil through a 6000ft 12-in diameter wharfline to the shore tanks of the installation. To prevent the heavy furnace oil from solidifying and blocking the line, a " Go-Devil " system is used. This consists of a specially-designed mechanical device, which, on completion of discharge, is inserted at the seaward end of the pipeline. With the aid of compressed air, it is then forced through the full length of the line. This effectively clears away the oil, leaving the line in good condition to receive the next consignment. On completion of its journey, the device is withdrawn at the outlet end of the pipeline. New to Australia, the use of the " Go-Devil " system eliminates the necessity for an internal heating line, and reduces the risk of the wharf pipeline becoming " plugged " with heavy oil during cold weather. A total of 1,750,000 gallons of furnace oil can be stored at the new terminal. The larger bulk tank has a capacity of 1,500,000 gallons, while the smaller working tank (insulated and fitted with steam coils to keep the furnace oils in fluid form) can accommodate 250,000 gallons. As required, the furnace oil is drawn from either bulk tank, using a steam suction heater to keep it in fluid form for easy loading into rail tank cars or road tank wagons for delivery to Australian Iron and Steel, Ltd., and other consumers in Port Kembla.

Technical Reports

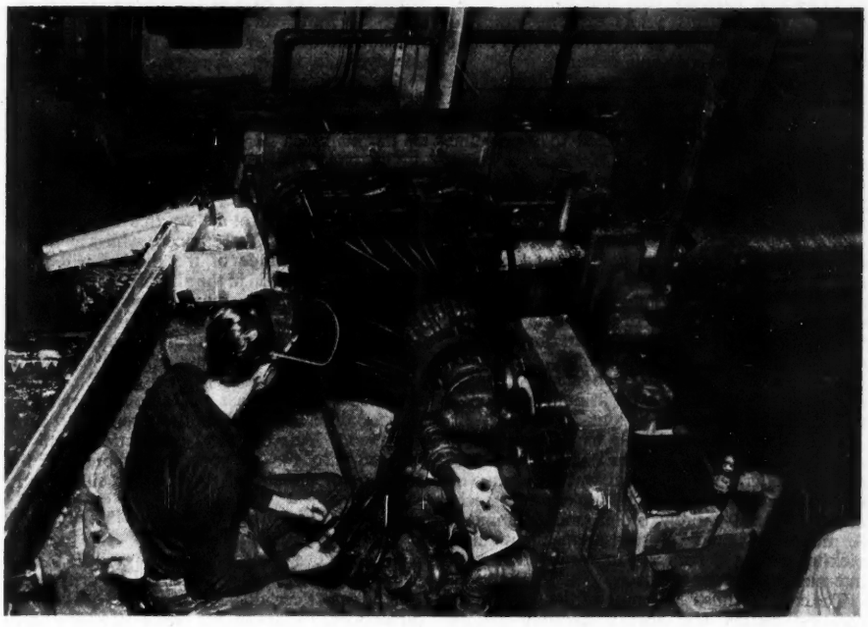
National Building Studies Research Paper No. 14 : " *Reactions Between Aggregates and Cement. Part* 1 : *Alkali-Aggregate Interaction : General.*" D.S.I.R. London : H.M. Stationery Office. Price 1s. 3d.—Attention was first drawn to the possibility of concrete seriously deteriorating through chemical action between the constituent cement and aggregates when a paper given to the American Society of Chemical Engineers in 1940 suggested that several failures of concrete structures had been due to this cause. Although no large-scale failures have taken place in this country there have been many failures elsewhere and much investigation has been carried out on the problems of the causes and effects of reactions between aggregates and cements. The present publication is the first of a series of reports which will deal with alkali-aggregate problems. It describes the early investigations in the United States and the theories on the subject. There are various chemical reactions which can be the cause of breakdown in concrete structures, it is stated, one of the most important being that of siliceous aggregates with sodium and potassium hydroxides released during the hydration of cement. The alkali silicate gel formed in this way can swell sufficiently to crack the concrete. The mechanism of expansive pressure is not yet fully understood, however, but current theories on the subject are briefly described. The report deals with observations made on concrete dams, bridges and buildings in the U.S.A. and with tests on the types of reactive aggregates used in their construction. Test methods are described and recommendations for the prevention of expansion due to chemical reactions are given.

A Continuous Aluminium Casting and Rolling Installation

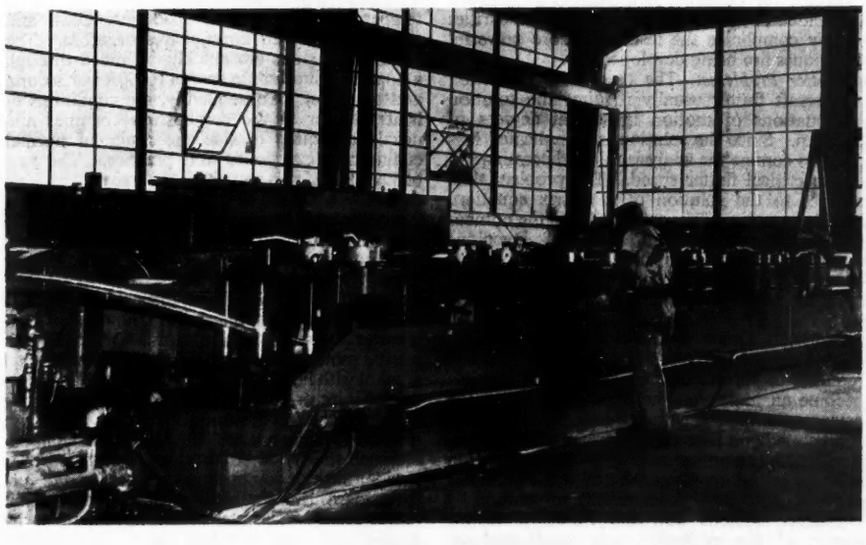
A machine for continuously casting aluminium and its alloys into long horizontal bars has been developed by, and installed at the works of, the Hunter Douglas Corporation at Riverside, California. The continuously cast bars are subsequently hot rolled to strip, which is mainly used as slat stock for the production of venetian blinds. On account of the high surface and edge quality of the strip, scalping and edge trimming operations are not required.

THE equipment now in operation at the Riverside works of the Hunter Douglas Corporation was designed to produce aluminium alloy strip up to 7in in width, but is capable of producing strip of greater width. The continuous casting speeds used at present range from 4ft per minute to 15ft per minute, depending upon the composition of the alloy and the geometry of the bar, current production being confined to a bar 7in wide by 1in thick, which is sheared into 55ft lengths.

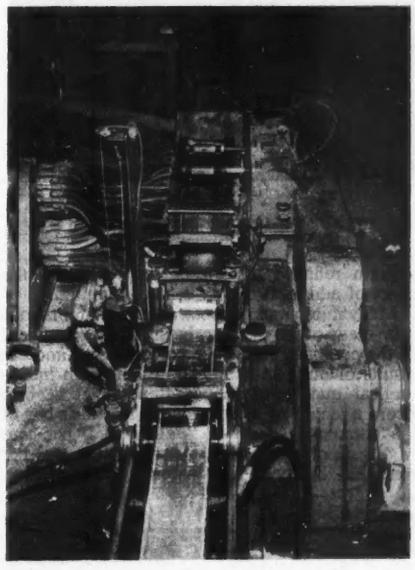
A constant reservoir of aluminium alloy is provided by a battery of three Ajax low-frequency induction furnaces, which are capable of melting and alloying a maximum of 6000 lb of metal per hour, and as each furnace completes its cycle the metal is poured into a 20,000 lb gas-fired reverberatory holding furnace. The metal is supplied from the reverberatory furnace through an open trough to the casting machine and a constant level and an unbroken liquid metal surface is maintained by means of a manually controlled adjustable tap hole valve. Several machines can be attached to a single holding furnace. Our illustrations show the casting machine in operation, with the molten aluminium alloy flowing into the machine from the holding furnace at the left. The metal enters the casting machine through a specially designed tip and flows into the cavity formed by the mould segment halves, which are parts of an upper and a lower moving chain, each resembling the track of a caterpillar tractor. Synchronisation of the two chains results in a continuously moving horizontal mould. The chains consist of heat-treated cast iron blocks, drilled for water cooling and closely machined to obtain a precision fit, to form a smooth mould cavity in which the aluminium solidifies. The solid, hot aluminium bar leaves the machine at temperatures ranging from 750 deg. to 1000 deg. Fah., depending upon the chain speed and the mass of the bar. Guide rolls are provided and a flying shear, tripped by a micro-switch, cuts the bar to the length required.



Casting Machine



Six-Stand Tandem Mill



Exit End of Casting Machine

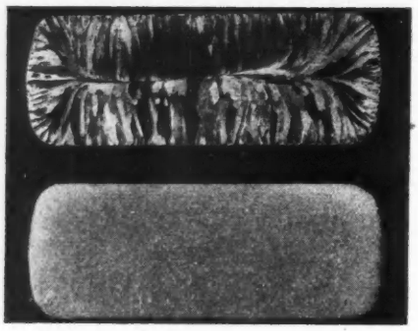
The cast bar is mechanically guided and rolled into a horizontal holding oven to be heated or cooled to the desired hot rolling temperature. It is moved transversely out of the way of the next bar being cast and is conveyed by means of pinch rolls to the hot mill. This six-stand tandem mill, which we illustrate, reduces the 1in thick by 7in wide by 55ft long bar into a 450 lb coil of $\frac{1}{4}$in thick strip in about one minute, there being few edge cracks, despite the absence of edge rolling and the use of an unmachined bar. The final cold reduction from the hot-rolled 0·125in strip to the finished venetian blind coil stock gauges, ranging from 0·007in to 0·0092in thick, is obtained on a high-speed six-stand tandem mill without intermediate annealing.

Soft aluminium alloys and those not prone to coring or other metallurgical segregation, may be rolled immediately after the bar is cast, and certain special heat-treatable aluminium alloys, developed by the company for high-strength strip applications, also do not require a homogenisation heat-treatment for satisfactory hot rolling. However, the commonly used high-strength alloys generally require the usual soaking heat-treatment to improve the rolling characteristics by eliminating coring, alloy segregation and by spheroidising any insoluble intermetallic compounds.

Metallurgical Structure

The excellent hot rolling characteristics of the continuously cast bar are considered to be due largely to the soundness attained from the pronounced directional solidification which is facilitated by the Hunter Douglas casting machine. The surface temperature of the water-cooled mould segment blocks is about 100 deg. Fah. when contact is made with the molten metal and the solidification gradient is so great

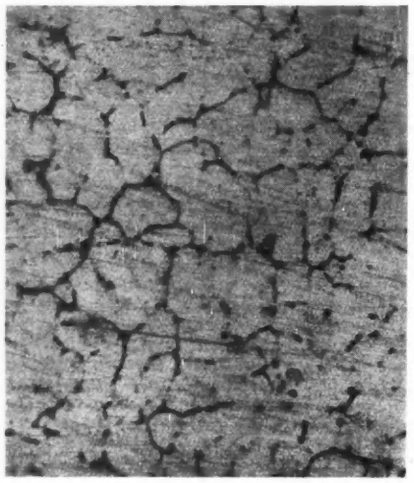
that continuous feeding of molten metal at the tip can be achieved. In some alloy compositions, having no grain refining additions, the steep thermal gradient during solidification is made evident by the coarse columnar grain structure of the bar. However, when a small amount of titanium is added to the same material a fine-grained, equi-axed structure results. The upper section in our illustration shows an alloy without



Grain Structure

a grain refiner; the lower section shows the effect of adding 0·03 per cent of titanium.

Many micro and macrostructural examinations were made of the cast bar during the development of the company's special wrought alloys and the results of one test demonstrates the high metallurgical quality of the continuously cast bar. From a length of a 7in wide by 1in thick bar of the company's "HD-11" alloy, (1·0 per cent Mg, 0·6 per cent Mn, 0·6 per cent Cu, 0·8 per cent Si, balance Al), several standard ½in.



Microstructure of Bar × 140

diameter tensile bars were machined and the remainder of the bar was hot rolled to a 0·125in thickness, as in daily production practice. Specimens machined from the strip were solution heat-treated at 1020 deg. Fah., quenched, and aged four hours at 350 deg. Fah. The average results were :—

	As cast	As rolled
Tensile strength, lb per sq in	51,500 ...	53,500
Field strength, lb per sq in (0·2 per cent offset)	42,000 ...	42,000
Elongation in 2in, per cent	10 ...	14

The fine dendritic structure of the cast bars tested is shown in the photomicrograph reproduced herewith.

When operating at full capacity the two continuous casting machines at the Riverside Works are capable of casting bar at an average daily rate of 70,000 lb to 80,000 lb. Commercial compositions which have been satisfactorily cast and hot worked to date are those conforming to the American Specifications 2S, 3S, 4S, 52S, 61S, and 24S. Most of the tonnage, however, has consisted of two aluminium alloys specifically developed by the company for high-strength venetian blind applications. One alloy develops "as-rolled" properties ranging between those of 52S and 56S aluminium alloy, while the other alloy possesses properties in the heat-treated condition comparable to those of heat-treated 24S aluminium alloy. The table above lists the chemical composition and certain mechanical properties of the American aluminium alloys in the annealed condition.

Properties of American Aluminium Alloys

Alloy symbol	Nominal composition, per cent						Tensile strength, pounds per square inch	Elongation, per cent in 2in
	Cu	Si	Mn	Mg	Cr	Al		
2S	—	—	—	—	—	99·0+	13,000	45
3S	—	—	1·2	—	—	Bal.	16,000	40
4S	—	—	1·2	1·0	—	Bal.	26,000	25
24S	4·5	—	0·6	1·5	—	Bal.	27,000	22
52S	—	—	—	2·5	0·25	Bal.	27,000	30
56S	—	—	0·1	5·2	0·1	Bal.	42,000	35
61S	0·25	0·6	—	1·0	0·25	Bal.	18,000	30

Some Aspects of Research at the Royal Aircraft Establishment

EACH year on the Ministry of Supply stand at the S.B.A.C. Exhibition some aspects of the basic aerodynamic research carried out at the Royal Aircraft Establishment are illustrated. One of this year's exhibits indicated the use to which the guided missile was being used to facilitate supersonic research.

Guided missile flight-testing techniques have been developed to the stage at which they form a vital factor in basic aerodynamic research. The missile or model is boosted to supersonic speeds, usually in excess of $M=2$, by a boost unit that separates from the dart when the propellant is all burnt. During the coasting flight that follows, standard techniques are now available for the study of drag, aileron power, damping in roll, and the stability and control parameters applicable to the pitching and yawing motions. Most of the information required is obtained from an analysis of the missile response to carefully planned control movements, although, in some cases, it is more convenient to produce disturbances from steady flight—a 10*g* turn, for example—by firing small rocket motors in a transverse direction.

The success of flight-testing techniques largely depends upon the instrumentation. Some measurements, such as visual tracking data, or radial velocities found by Doppler radar techniques, depend entirely on ground equipment. A more vital range of measurements requires pick-ups within the missile in conjunction with internal recorders or telemetry.

The exhibits illustrated some of the techniques, showing results and instrumentation for an aerodynamic test vehicle. An important feature is that all the required aerodynamic parameters have been determined, although the pitching moment, for example, is a non-linear function of incidence. Nevertheless, such non-linearities greatly complicate the tests and more powerful techniques are being developed.

Flutter Problems.—The theoretical prediction of aircraft flutter usually requires the solution of equations of motion in several degrees of freedom. Since the solution is complicated it is usual to confine the analysis to the determination of the critical flutter speed. The problem then reduces to the solution of a matrix equation, usually complex, of the same order as the number of degrees of freedom. Several ingenious mathematical methods have been evolved to reduce the labour of calculation, but the solution is rarely easy and, in addition, the effect of any variation in the coefficients is often only to be found by the solution of a new matrix equation.

A large amount of time and skilled effort is required to solve flutter equations, and this has become an important factor in determining the extent to which accurate flutter investigations can be made on new aircraft. A machine, therefore, which can appreciably speed up the solution of these equations is very desirable. The flutter problem lends itself most readily to solution by analogue methods and the flutter simulator shown at the exhibition was constructed on these principles, using a system of electrical networks combined with electronic amplifiers to represent mechanical oscillations. By adjustment of the values of certain of the network components the natural oscillations of an aircraft structure can be simulated. By further adjustment of other parts of the network the aerodynamic forces acting on the aircraft in flight are introduced and their variation with air speed can be controlled by the operator. The critical flutter speed is determined by that setting of the air speed control at which the electrical oscillations of the machine, representing the mechanical oscillations of the aircraft, are of constant amplitude. Normally at settings of the air speed control below this critical value the oscillations will be damped, whilst at higher values the amplitude of the motion will grow rapidly. A variation in the aircraft characteristics can easily be represented and the resulting change in the critical flutter speed found. Greater understanding of the critical flutter oscillation can be obtained by the use of auxiliary equipment. The frequency of the oscillation can be recorded and the phase and amplitude relationship of different parts of the aircraft structure observed. An electrical oscillation can be injected into the network to demonstrate the response of the aircraft to forced oscillations in flight.

Rocket Motors

Whilst developments in the guided missile field are largely concealed by security considerations, certain components developed directly or indirectly for these weapons have been described. In the case of rocket motors heat transfer problems abnormal in character have been encountered.

Rocket motor propellants burn with flame temperatures as high as 3000 deg. Cent. and at pressures of 20 atmospheres or more. The combustion gases are quickly expanded through a nozzle to supersonic speeds (6000ft per second and upwards). Consequently, the conditions of heat transfer to the combustion chamber and nozzle are quite outside the range of normal engineering experience and practice. The rate of heat transfer is very high; it may be as high as 10 B.Th.U. per square inch per second; in fact, the heat passing into a 1in length of the wall of a nozzle at a throat, 2in in diameter, is sufficient to bring a pint of water to the boil in about three seconds.

An exhibit associated with this problem showed a technique used for measuring the rates of heat transfer in rocket motor nozzles. An experimental motor has been developed to burn methyl alcohol with liquid oxygen. It consists of a water-cooled injector plate, a heavy uncooled steel tube forming the combustion chamber and an uncooled copper nozzle. The burner and chamber are such that good combustion is obtained over a wide range of combustion pressures and of fuel to oxidant ratios (this varies the combustion temperature). The methyl alcohol may also be diluted with water to extend the range of operating conditions still further.

The convergent-divergent nozzle is turned from a solid copper billet and a number of thermo-couples are distributed through the body of the nozzle to record the temperature distribution. Rotary switches are arranged to scan the thermo-couples once every second, or as required, and the e.m.f.s are recorded photographically. The motor is run for ten to forty seconds according to the operating conditions, the duration being determined by the time taken for the surface temperature of the copper at the nozzle throat to reach 500 deg. Cent.

Another exhibit featured a Beta II rocket motor which was designed as a propulsion unit for an experimental model aircraft to deliver a thrust of 2500 lb for forty seconds. The general design and development of the motor was carried out by the Rocket Propulsion Department, R.A.E., Westcott, while the manufacture and design of the motor as a power plant was undertaken by the Fairey Aviation Company.

The oxidant is 80 per cent hydrogen peroxide and the fuel "C-fuel," a mixture of methyl alcohol, hydrazine hydrate and water. The fuel and oxidant are self-igniting on mixing, so that no special ignition arrangements are necessary. The propellants are pumped from the tanks in the aircraft to the combustion chambers by means of a turbo-pump unit. The specific propellant consumption (including turbine) is 0·565 lb propellant per pound thrust per second, the total consumption being 14 lb per second.

One such turbo-pump unit was exhibited with which it is convenient under certain circumstances to pump the fuel instead of using pressurised fuel tanks for this purpose. These units must be very small in size and weight, simple and safe in operation and easily made. Their design is different in many respects from that of conventional centrifugal pumps. The full delivery pressure, which amounts generally to between 300 lb and 800 lb per square inch, is developed in one single stage. Though the impeller blades are extremely simple, the efficiencies are not inferior to those obtained with conventional impellers operating under the same conditions. The pumps include neither a high-pressure seal nor any small clearances, so that any danger of wear and seizure is eliminated. Very small impeller diameters can be used due to the high operational shaft speed.

In a bi-propellant motor two of these pumps—a fuel pump and an oxidant pump—are generally directly coupled to a small high-speed turbine with which they form a compact unit. Very safe shaft seals utilising a minimum axial space are another important feature of these turbo-pumps. The seals operate only under inlet pressure which is centrifugally balanced by a simple sealing impeller. Under static conditions of the unit a contact seal, which is lifted off its seat during operation, prevents leakage along the shaft.

From other exhibits on the stand and by the aid of a film, the complex stressing of turbine and compressor blading, due to fluctuations in the gas flow, could be realised.

In order to investigate the modes of vibration excited by these alternating forces the methods of ascertaining nodal patterns of compressor and turbine blades has had to be extended to cover frequencies of 30,000 c/s for turbine blades and 100,000 c/s for compressor blades.

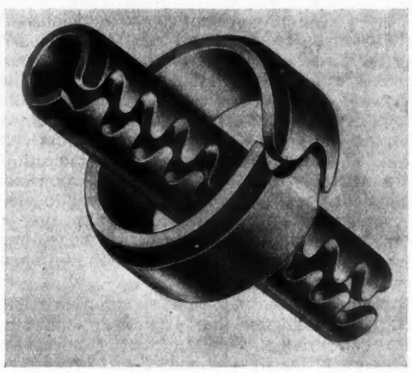
In addition to the above forced vibration there is a possibility of self-induced vibration in axial-flow compressor blades. In high performance compressors, i.e. with high-pressure ratios and high mass flows—there is a possibility of self-induced vibration in the early stages when operating at high incidence at or near the stall, usually occurring at medium rotational speeds.

Spring Pins

We have received from the International Corporation, Ltd., 19, Ebury Street, London, S.W.1, particulars of "Connex" spring pins which have been developed by a continental firm to replace the conventional parallel or taper pin. Unlike the usual design of spring pin consisting of a straight slotted spring steel tube, these new pins have a toothed slot.

Slotted pins when inserted in a hole are compressed and exert a uniformly distributed radial pressure in the hole to lock themselves in position, and their use makes reaming and precision fitting unnecessary. When straight slotted pins are used as keys it is necessary to ensure that the line of the slot is not along that of the joint between two components, but it is claimed that with a pin with a toothed slot this care in positioning is not called for because the teeth interlock to make the pin as stiff as an unbroken tube.

In the photograph we reproduce the tooth form which has been developed can clearly be seen in one of the new slotted spring pins. This tooth form was developed following investigations of the behaviour of pins under compression, and it is so designed as to produce a slight axial deflection of the edges of the slot. This deflection



Spring Pins With Toothed Slots

results in bringing the whole circumference of the pin into contact with the hole thus greatly increasing the effectiveness of the pin.

The makers of the pins point out that in any component under load there is a section in which the bending, torsional or shear stresses are greatest, according to the method of loading. A spring pin with a straight slot is subjected to bending only and the maximum stress concentration is opposite the slot. Failure eventually occurs in this place and the amount which the pin can be compressed is limited for any given material by the stress in this section. This limitation, it is stated, can be overcome, without increasing the wall thickness of the pin, by introducing new evenly distributed stresses which are independent of the bending stress or tend to reduce it. The new toothed slot in spring pins has this effect and in reducing the bending stress is claimed to utilise the available material to much better effect.

Power Sources in Arid Zones

Plans for developing sources of power in arid zones through wind and solar energy are to be discussed by Unesco's Advisory Committee on Arid Zone Research at the Royal Society, London, from September 29th to October 1st. The committee will also consider other questions related to this field, including the setting up of an arid zone development centre. The members of the committee are: Dr. Hassan Awad, secretary-general of the Royal Geographical Society, Egypt; Mr. Richard L. Boke, regional director of the Bureau of Reclamation for California; Dr. B. T. Dickson, liaison officer for the executive committee of the Commonwealth Scientific and Industrial Research Organisation, Australia; Mr. A. N. Khosla, additional secretary to the Government of India at the Ministry of Irrigation and Power, New Delhi; Professor Roberto Llamas, director of the National Institute of Biology, Chapultepec, Mexico; Professor Joseph Peros, of the Science Faculty of the University of Paris; Professor L. Picard, Director of the Israeli Geological Institute; Dr. H. G. Thornton, F.R.S., Head of the Soil Microbiology Department at the Rothamsted Experimental Station at Harpenden, Herts, and Dr. Jacobo Zender, Director-General of Agriculture at the Ministry of Agriculture, Peru.

Unesco's aim in this field is twofold: first, to discover and make available the experience and expert knowledge gained from the experiments and projects carried out in many parts of the world, and, secondly, to help the creation and the extension of research stations for the study of arid zone problems. Each year, Unesco selects a particular field of research for study. In 1951 it was water—the one problem common to all arid and semi-arid areas. Eight scientists were commissioned to study and report on current research on this subject. Last April, at an international symposium in Ankara, Turkey, scientists met to consider their findings. The results of their discussions will provide research workers with the first comprehensive picture of the properties of underground water and the possibilities of using it effectively in arid zones.

This year, Unesco has selected plant ecology—the relation of plants to their environment. A group of ten plant ecologists are surveying this field and assembling experimental and research data on species and strains which thrive under dry conditions in one area and which may profitably be introduced into others. The surveys will also provide background information for an international symposium on this subject proposed to be held in a Latin American country in 1953.

British Standards Institution

All British Standard Specifications can be obtained from the Sales Department of the Institution at 24, Victoria Street, London, S.W.1.

MALLEABLE CAST IRON AND CAST COPPER ALLOY PIPE FITTINGS (SCREWED B.S.P. TAPER THREAD OR A.P.I. LINE PIPE THREAD) FOR STEAM, AIR, WATER, GAS AND OIL, AND MALLEABLE CAST IRON (WHITEHEART PROCESS) AND CAST COPPER ALLOY PIPE FITTINGS (SCREWED B.S.P. TAPER MALE AND PARALLEL FEMALE THREAD) FOR STEAM, AIR, WATER, GAS AND OIL.

No. 143 : 1952 and No. 1256 : 1952. These standards have been revised with a view to simplifying the range of sizes of fittings and to provide only for those sizes of fittings in common use. They specify the standard dimensions of plain and reinforced malleable cast iron and cast copper alloy pipe fittings suitable for working pressures up to 200 lb per square inch in the case of water, and up to 150 lb per square inch in the case of steam, air, gas and oil. They also provide for the customary types of equal and reducing fittings for use with nominal pipe sizes within a range of ¼in to 6in. Tests for porosity and ductility are specified.

In the revised B.S. 143, provision has been made for the fittings to be screwed with A.P.I. threads to meet the requirements of the petroleum industry. Price 7s. 6d.

TERMS AND DEFINITIONS FOR SINGLE-POINT CUTTING TOOLS

No. 1886 : 1952. A very detailed set of definitions of the numerous terms used in connection with single-point cutting tools for lathes and related machine tools has been brought together in this British Standard. The standard was prepared with the assistance, among others, of representatives of the British Hard Metal Association and the Welded and Brazed High Speed Steel Tool Trade Association. It first presents definitions of various types of single-point tools and then deals with rakes, working angles, clearance angles, tool elements and general terms.

The definition of rake has received special attention and, as a result, it is laid down that the Maximum Rake System shall be the British Standard method of defining rake, as distinct from the German or American systems. An appendix is devoted to extracts from Dr. Galloway's book, *Standardisation and Practical Application of Cutting Tool Nomenclature*, published by the Institution of Production Engineers. The extracts on a method for the conversion of rake angles have been slightly amended where necessary to bring them into line with the Maximum Rake System nomenclature. The standard concludes with the introduction of the rake conversion chart from the work quoted above. The terms defined are those for actual single-point tools and do not refer to such tools as milling cutters. Price 6s.

African Engineering News

(By our South African Correspondent)

Cape Main Line Electrification

The electrification of the Cape Town–Johannesburg main line through the mountains and vineyards of the Western Province from Bellville to Worcester, a distance of 97 miles, is nearly complete, and electric trains are expected to start operating within a few months. The programme provides for electrification as far as Touws River, a further 51 miles, and construction of this second stage is well advanced.

The estimated cost of electrifying the line between Bellville and Touws River, including the Stellenbosch loop line and the provision of substations, is £2,700,000, of which £1,564,712 was spent by the end of April. The work on the electrification of the line, which was started in October, 1949, is now nearing completion to Worcester, and it is expected that the whole of the 148 miles from Bellville to Touws River will be electrified by June, 1953. Progress has been hampered by a world shortage of copper, resulting in delay in the delivery of contact wire and substation plant. The position has, however, improved and supplies are now arriving more satisfactorily.

As a direct result of the Bellville–Touws River electrification, the Electricity Supply Commission has built a £3,600,000 power station at Worcester, as well as a new transmission system. The new power station will supply electric power to the Railway Administration as well as to industries throughout the Cape Western Area, and thus relieve the Cape Town power stations. One generator of the Worcester power station is already feeding power into the network in order to assist with the serious power shortages at Cape Town.

Forty class "4 E" electric locomotives at a cost of £1,786,000 as well as ninety-two electric motor coaches to cost £2,596,000, are on order for the Cape Western system. The first class "4 E" electric locomotive arrived at Durban during the middle of June. The first ten to arrive will be used temporarily in Natal. The "4 E" is the heaviest electric locomotive yet ordered by the South African Railways, and the most powerful ever built for a 3ft 6in gauge railway. It is 72ft long, weighs 155 long tons, and has a total locomotive one-hour rating of 3030 h.p. and a maximum speed of 60 m.p.h.

The existing electrified suburban stock at Cape Town, which has been in use since 1928, operates on a 1·5kV overhead supply. The motors and bogies have now reached a stage where they require extensive modification or complete renewal. The present supply voltage has been found from experience on other electrified sections not to be the most economical for power traction, and it was therefore decided that the main line electrification between Bellville and Touws River should be on the 3kV system. All electrification in the Cape is to be changed over to operation at 3kV in order to obtain the maximum flexibility and efficiency.

Parallel with the electrification of the main line from Bellville to Touws River, modern mercury arc rectifier substations are being installed on the sections Cape Town–Bellville, Cape Town–Simonstown and the Cape Flats line. These substations will initially supply 1·5kV to the existing suburban services and have been designed to enable rapid change-over to 3kV when the conversion of the suburban services takes place. The conversion of the Cape Town–Bellville and the Cape Flats sections to 3kV will take place probably in June, 1953, followed early in 1954 by the conversion of the Cape Town–Simonstown section. For this programme a total of ninety-two new 3kV electric motor coaches will be required, and twelve of the more modern existing type will be converted for 3kV operation.

The new coaches will be 75 per cent more powerful than the existing stock, permitting of accelerated services and providing for denser traffic conditions. The new motor coaches will be cheaper to operate, and there will be a substantial saving in specific power consumption. The acceleration of the coaches is very high, and as all the Cape passenger coaches are being converted to an improved system of braking operated on the electro-vacuum principle, the running time of trains with frequent stops will be further improved. It is estimated that when the whole line between Bellville and Touws River has been electrified, the running times of goods trains will be reduced by approximately 90 minutes in each direction, while those of passenger trains will be about 45 minutes shorter than the running times shown in the present time-table.

Running sheds and a modern electric locomotive depot are being built at Salt River at a total cost of £935,000 for the purpose of servicing the new electric passenger motor coaches and locomotives.

The O.F.S.–Natal Railway Line

The development of the gold mines in the Orange Free State and industrial expansion in the Kroonstad area have resulted in a considerable increase in traffic on the railway line between this centre and Natal. During 1951 a total of 17,313,207 tons of goods came from or passed through Kroonstad, an increase of 846,250 tons compared with 1949. Indications are that the volume of traffic on the Kroonstad–Natal line will continue to grow, and to meet the position the Railway Administration is undertaking and will, in the course of the next few years, embark on various improvement schemes.

A major project, aimed at speeding up traffic, is the doubling of the Natal main line from Pietermaritzburg to Danskraal (Ladysmith). This work, the total estimated cost of which is nearly £6,300,000, is being carried out in stages, and, up to the present, the sections Tweedie–Lions River (3 miles) and Dargle–Lidgetton (3 miles) have been opened to traffic. Between Nottingham Road and Rosetta (4 miles) the earthworks and culverts, as well as 80 per cent of the track work, have been completed. The doubling of the line between Rosetta and Mooi River (9 miles) involves a deviation and the building of a twin tunnel. Earthworks and the construction of culverts and subways are well in hand, and work on the tunnel is to be commenced shortly. Between Mooi River and Estcourt the deviation is being set out, and a start has been made with the remodelling of Estcourt station.

Approximately 60 per cent of the earthworks and of the work connected with the building of a twin tunnel about 900ft long between Estcourt and Ennersdale (8 miles) has been completed. Work has been commenced on the section Frere–Pieters (20 miles). Between Pieters and Umbulwana the line has been surveyed and the plans are being prepared.

The volume of traffic has outgrown the capacity of the marshalling yard at Gunhill, near Kroonstad, and it has been decided to provide a new unmechanised hump marshalling yard on a site on the north side of the river. This site, which has been acquired from the Kroonstad Municipality, is situated near the new industrial area of this fast-developing Free State town. A start has already been made with the first stage of the scheme, which comprises the construction of railway lines to connect the O.F.S. main line with the site of the new yard and the provision of a number of marshalling and shunting tracks. The first stage will cost nearly £340,000, of which £200,000 will be spent during the financial year 1952–53. The new tracks to be provided as the first portion of the scheme will supplement the facilities in the Gunhill marshalling yard, but will be expanded gradually.

The increase in traffic also necessitates the provision of improved and additional facilities in the marshalling yard at Danskraal, but before the work can be undertaken it is necessary to deviate the Natal–O.F.S. line out of Ladysmith. In the Capital and Betterment Estimates for the year 1952–53 an amount of £138,300 has been provided for this deviation, and £20,300 will be spent during the current financial year. It is the intention in future years to improve the section Bethlehem–Harrismith by means of several large-scale deviations.

French Engineering News

(By our French Correspondent)

Oil prospecting is now going on in the Sarthe department of France. There appears to be every reason to believe that oil deposits exist in Ferte-Bernard.

* * *

The Algerian iron mines at Ouenza are being modernised in order to increase production. In 1951, it is now reported, the mines produced 980,000 tons of ore as against 880,000 tons in 1950. In 1950, some 540 million francs were spent in modernisation, and in 1951 this figure was 630 million francs. For the first eight months of 1952 between 700 million and 800 million francs was spent.

* * *

Results of the trials of the first French gas turbine locomotive, tried out on the Paris-Cambrai line, have now been published. This locomotive, the 040-GAI, built by Renault, has a speed of 125km per hour. The trials are said to have been quite satisfactory.

* * *

American concerns are now placing orders with French shipbuilding yards. The Chantier et Ateliers de St. Nazaire, which recently built the "Bethsabee" and the "Berenice" tankers, has received orders for eight similar craft, two from America. The firm now has nine tankers under construction.

* * *

"Sollac," the combined steel enterprises with plants in the east of France, is now trying out new strip rolling installations, which will come into service in a few weeks' time. It is hoped that with the new installations in production France will not have to import any more thin sheet, and, in fact, it is hoped to develop an export trade. The new installation is situated near the iron mines at Hayange, one new plant being at Ebange and the other at Seremange. It is estimated that the two plants will be able to produce some 70,000 tons per month. During the first year, however, production will be restricted to 50,000 tons.

* * *

Active preparations are now going ahead for the automobile salon, which opens on October 2nd. It will be the thirty-ninth salon. Little really new is expected to come out of the salon this year. The accent will be on improvement of existing models. About 101 manufacturers will show their cars. They will include British, American, German and French builders.

* * *

Gaz de France, in its fifth annual report, announces that a new process called "autothermique" is now being used for the production of propane, which Gaz de France is selling either in its pure form or mixed with air. This system, it is pointed out, permits the mixing of pure propane with ordinary lighting gas. The result is that the propane takes on the characteristics of town's gas and burns much in the same way. Production on an industrial scale has only just started. Experiments and trials were carried out at the Maintenon gas plant, but large scale production will start at Angers. The plant at Gennevilliers, it is noted in the report, is producing a gas from fuel oil by the "Hall" process. This system is considered highly economic. The gas has high calorific power and is being used to enrich poorer gas. Experiments are also being carried out in which it is hoped to produce a gas from heavy oil, which will be as satisfactory as town's gas. At Cahors another, and undivulged, method is being tried out for producing gas from fuel oil. It is understood that the basis is catalytic cracking. The gas produced is said to have all the characteristics of town's gas. It is interesting to note that for the first time since Government subsidies ceased, Gaz de France made a profit of £8879. Although this is very small, it is nevertheless considered satisfactory.

Industrial and Labour Notes

Average Weekly Earnings and Hours

The Ministry of Labour has now published a report on an inquiry which it made last April into the average weekly earnings and working hours of manual wage earners employed in manufacturing industries generally and in a number of non-manufacturing industries in the United Kingdom. Returns were furnished to the Ministry by about 59,700 establishments, the number of wage-earners covered by them being approximately 6,500,000. It is estimated that these returns covered rather more than two-thirds of the total number of wage-earners employed in the industries concerned at the time of the inquiry. The figures included in these returns related in all cases to the last pay week in April.

During that week, the Ministry says, the average earnings in all industries were as follows: men of twenty-one and over, £8 13s. 7d.; youths and boys, £3 11s. 9d.; women of eighteen and over, £4 12s. 2d.; girls, £2 17s. 9d. In the manufacturing industries alone the average earnings were: men, £8 19s. 4d.; youths and boys, £3 9s. 4d.; women, £4 12s. 6d., and girls, £2 18s. 2d. The report goes on to state that in the manufacturing industries the average hours worked in the last pay-week in April were: men, 47·1 hours; youths and boys, 43·7 hours; women, 40·8 hours; girls, 41·6 hours. In the group of manufacturing industries classified as "engineering, shipbuilding and electrical goods," the average weekly earnings were: men, £9 4s. 8d.; youths and boys, £3 5s. 6d.; women, £5 0s. 4d.; and girls, £3 1s. 8d., the average hours worked being 48·2, 44, 42·1 and 42·4 hours, respectively.

Dealing generally with earnings in the last week in April in all the industries covered by its survey, the Ministry says that for all workers they were 177 per cent higher than in October, 1938. It is estimated that, for these same industries, the index of rates of wages (April, 1947=100) was 129 for all workers at the end of April, 1952. The Ministry's report says also that there have been some increases in rates of wages since the last pay-week in April. It is estimated, however, that the effect of these increases has not raised the average general level of full-time weekly wage rates in the industries covered by the inquiry by more than about two-thirds of 1 per cent during the months May to August, inclusive.

Wages and Costs

The annual meeting of the General Electric Company, Ltd., was held on Thursday of last week, when, in the course of his chairman's address, Sir Harry Railing urged that industry must be allowed to earn and, after taxation, to retain sufficient capital. The sufficiency of industrial capital, he said, was of fundamental importance to the nation. Without it, assets of man-power, plant, minerals and gold reserves were wasted, and the increased production, which was essential if living standards were to be maintained, could not be obtained.

Sir Harry went on to say that the next truth which must be universally recognised was that we could not carry on with low average outputs per man, per square foot of floor space, and per machine. Unless there was full output from all of them, it would be impossible to keep to the costs of our competitors. That, he pointed out, was why it had become increasingly impossible to accede to wage demands unless they were linked with greater output. Rewards, Sir Harry observed, were only possible for the efficient producer, not the average one; for those who either on account of higher skill, greater application or longer working hours made a higher contribution per man year and thus enabled us to achieve competitive costs. Customers abroad would not pay us for inefficient methods; neither would they pay us for workers who were less efficient, worked shorter hours or demanded a higher standard of living—however desirable—than those of other suppliers.

That, Sir Harry continued, applied not only to the manufacturing industry, but equally to the sheltered industries and services. They, no less than those who directly felt the impact of world competition, were affected because every wage increase in the cost of distribution, in the cost of transport and in the cost of building, immediately increased the cost of living and reduced the volume of food and raw materials which could be bought from abroad. Overseas orders, Sir Harry added, could only be obtained assuming equal quality, on price and delivery. Any direct or indirect demand, any measure which increased cost price or delivery, automatically handicapped our national economy and reduced the standard of living.

Europe's Steel Production

The United Nations Economic Commission for Europe has issued this week its *Quarterly Bulletin of Steel Statistics*, which deals mainly with production trends in the second quarter of this year. It is estimated that, during the second quarter, crude steel production was maintained at an annual rate of 61,900,000 metric tons compared with a rate of 62,420,000 metric tons in the first quarter. The slight decline, the *Bulletin* says, is no doubt accounted for by the holiday period. At the same time, steel production in the United Kingdom, France and Italy was at a higher rate in the second quarter than in the first.

Dealing with raw material supplies, the *Bulletin* records a satisfactory increase in pig iron production, despite a continuing tightness in coke supplies. But the scarcity of scrap continues, the supplies of war scrap having now been practically exhausted.

Import and Export Prices

The Board of Trade has published the current index numbers of import and export prices and of the terms of trade based on 1951=100. The index number of import prices generally at the end of August this year was 96, compared with 103 a year earlier. During that period the biggest change has occurred in the prices of raw material imports, the index number being 87. It has fallen almost continuously since August, 1951, apart from two or three months at the turn of the year when raw material prices showed some tendency to rise again. The index number of imported manufactured goods at the end of August was 101.

The export price index at the end of August (1951=100) was 105 for all goods. In most export categories there was little or no change in price compared with the preceding month, although the price index for metals and engineering products advanced in August by one point to 114. The Board of Trade says that since April this year average export prices have fallen slightly which, with the greater reduction in import prices, has brought about improvement in the terms of trade.

Trade Disputes

Statistics given in the latest issue of the *Ministry of Labour Gazette* show that during the month of August there were in progress in the United Kingdom 166 stoppages of work through industrial disputes. In them, 44,200 workers were involved directly and indirectly, the aggregate number of working days lost being estimated as 165,000. Of the stoppages in August, 112 occurred in the coal mining industry, involving 37,400 workers and causing a loss of 79,000 working days. In the vehicle building industry there was a continuation of the stoppage of work, which began on June 24th, at Park Royal Vehicles, Ltd.

In the first eight completed months of this year there were 1162 stoppages of work through disputes reported, involving 269,300 workpeople and causing an aggregate loss of 1,335,000 working days. In the comparable months of 1951 the number of stoppages and working days lost was exactly the same as this year, though the number of workpeople involved was 276,500.

Engineering and Shipbuilding Wages

On Wednesday of last week, at a special meeting of the executive council of the Confederation of Shipbuilding and Engineering Unions, it was decided that a ban on overtime and a restriction on piecework in the engineering and shipbuilding industries should operate from October 20th. That decision arose from an earlier recommendation made by a conference of the executives of all the unions comprising the Confederation, following the final rejection by the employers' federations of claims for substantial wage increases. The two federations concerned—the Engineering and Allied Employers' National Federation and the Shipbuilding Employers' Federation—had already stated their willingness, in talks with the Ministry of Labour, that the matter should go to arbitration, but to that course the unions would not agree.

Last Thursday, representatives of the Confederation of Shipbuilding and Engineering Unions again discussed the situation with officials of the Ministry of Labour. In amplification of the decision to implement the overtime and piecework ban, the Confederation's representatives stated that whilst they recognised "the value of arbitration in appropriate circumstances, the employers' offer of arbitration at this stage was not acceptable." But they also said that the Confederation's executive was now "in a position to negotiate freely on the merits of the case." On Friday last a letter was sent by the Ministry of Labour to the Engineering and Allied Employers' National Federation and the Confederation of Shipbuilding and Engineering Unions inviting them to a joint meeting to be held yesterday (October 2nd). The letter mentioned that, whilst the responsibility for the determination of wages rested with the two sides of the industry, the Minister of Labour must have regard to the public interest. In view of the serious consequences, the letter continued, that would result from any dislocation of production on a wide scale in the engineering industry, having regard to its importance in the national economy, the Minister felt that there should be a meeting of the parties at an early date so that the position could be fully explored. Such a meeting, the letter added, would be on the strict understanding that it was without prejudice to either side and did not involve any prior commitment. Invitations to a similar meeting, to discuss shipbuilding wages, have been sent by the Ministry of Labour to the Shipbuilding Employers Federation and to the Confederation of Shipbuilding and Engineering Unions.

Index of Industrial Production

The index number of industrial production (1948=100), which is prepared by the central statistical office of the Treasury, has been estimated provisionally at 102 for all industries in July, compared with 111 in June. Figures for the corresponding months last year were 111 in July and 122 in June. The figures for June this year were affected by the Whitsun holiday and for July in both years by the annual holidays. For the manufacturing industries only, the index for July this year has been estimated provisionally at 104, compared with 114 in July, 1951. The Treasury says that information so far received indicates that the index number for all industries in August—a month affected by annual holidays—is likely to be 97 or 98.

Notes and Memoranda

Rail and Road

ROAD ACCIDENTS.—The Ministry of Transport has reported that casualties on the roads of Great Britain in July were 20,998, including 455 killed, 5122 seriously injured, and 15,421 slightly injured, as compared with a total of 21,811 in July, 1951. While the total number of casualties to pedestrians was practically the same as in July, 1951, there was an increase of forty-four in the number of adult pedestrians killed. There was, however, a drop of ten in the number of fatalities to child pedestrians. Preliminary figures for August show that total casualties were 20,881, compared with 21,819 a year ago.

TALYLLYN RAILWAY PRESERVATION SOCIETY.—The Talyllyn Railway, in North Wales, is now claimed to be the oldest surviving steam-hauled, passenger-carrying, narrow-gauge line in the world. It is 7 miles long and was opened in 1865. The railway still possesses its original locomotives and rolling stock. Following the death, in July last, of its owner and manager, there were fears that this unique line would have to close down unless some help was forthcoming, and on that account the Talyllyn Railway Preservation Society was formed. The object of the society is to ensure the survival of the line, with its locomotives and stock, not as museum exhibits, but as a going concern. The minimum annual subscription for membership is £1. The honorary secretary of the Society is Mr. P. B. Whitehouse, 18, Moorland Court, Melville Road, Edgbaston, Birmingham, 16.

OPENING OUT OF BROTHERTON TUNNEL.—Because evidence of deterioration and of settlement of side walls had grown during recent years, Brotherton tunnel, constructed in 1848 on the York-Sheffield main line of the North Eastern Region of British Railways, has been opened out to a cutting. The total length of the tunnel was approximately 320 yards. Only 100 yards at the north end of the tunnel had been driven through limestone, the remaining 220 yards being of cut and cover construction with a covering of approximately 1ft 6in over the crown of the arch. The construction of this latter portion, which has now been opened out, consisted of a brick arch, four rings thick, supported on side walls 4ft thick of fairly loose stone rubble backing, faced with masonry. In view of the very limited time of complete occupation of the line, as much of the excavation as could safely be removed without affecting the stability of the tunnel was cleared during the two weeks prior to possession being taken, and some 17,000 cubic yards of spoil was removed. By Saturday, May 10th, all excavation, which could be carried out with safety whilst traffic still operated, had been completed, leaving the tunnel arch and side walls bared and ready for demolition. The demolition of the tunnel was carried out by the use of explosives, and as soon as sufficient debris had been removed from the end of the length of tunnel being retained, construction of the new portal was commenced. The lines were restored for traffic operation as planned at midnight on Sunday, May 25th. It was decided to strengthen the 100 yards of tunnel remaining by pressure grouting.

Air and Water

BRITISH SHIPBUILDING RESEARCH ASSOCIATION.—At the recent annual general meeting of the British Shipbuilding Research Association, Mr. J. Ramsay Gebbie was elected chairman of the council. Mr. Charles Connell was elected vice-chairman.

INSTITUTE OF MARINE ENGINEERS.—The next examinations for admission to the Institute of Marine Engineers will be held as follows : Students (Common Preliminary Examination), April 14 to 17 and October 6 to 9, 1953 ; Graduates (Sections A and B of Associate Membership Examination), April 27 to May 20, 1953 ; Associate Members, April 27 to May 21, 1953. Syllabuses of these examinations, and particulars of exempting qualifications may be obtained from the Secretary of the Institute of Marine Engineers, 85, Minories, London, E.C.3.

"VENOM" NIGHT FIGHTERS FOR SWEDEN.—It has been announced in Stockholm that Sweden has placed an order with the de Havilland Aircraft Company, Ltd., for a number of "Venom" Night Fighters. Deliveries of the first of these aircraft, which will be fitted with de Havilland "Ghost" jet engines, built under licence in Sweden, are due to start later this year. The "Venom" Night Fighter is in large-scale production also for the Royal Air Force. Details of its performance are secret but its rate of climb to height and its combat effectiveness and manœuvrability at altitude are said to be outstanding.

Miscellanea

OIL REFINERY FLARE STACKS.—Five new flare stacks are being built at the Llandarcy, Grangemouth and Kent refineries of the Anglo-Iranian Oil Company, Ltd. These are based on the design of the Skylon. They will be about 250ft high and supported by cables while resting on a small registering ball at the base.

TRAINING OF CANADIAN ENGINEERS.—Thirty-five Canadian engineering graduates have arrived in this country to take up awards under the Athlone Fellowship scheme. The fellowships are awarded by H.M. Government to enable suitably qualified young Canadian engineers to avail themselves of post-graduate training in the United Kingdom. The scheme was first introduced last year, and awards are to be made anually. The fellowships cover the cost of transport, fees and maintenance and are tenable normally for a maximum period of two years. They are available for works training in one or more approved industrial organisations ; post-graduate study in a United Kingdom university or college or research establishment ; or for research in a United Kingdom university, leading to the degrees of M.Sc. or Ph.D. Twenty-seven of the present fellowships have been awarded to newly-graduated candidates and eight to graduates from industry.

DOWTY MINE PROPS.—The production department of the National Coal Board has prepared an information bulletin (No. 52/73) describing the construction and operation of the Dowty hydraulic prop. The particulars given in the bulletin are based on experience gained in the use of these props over the last three years.

INSTITUTION OF BRITISH AGRICULTURAL ENGINEERS.—The new session of the Institution of British Agricultural Engineers will begin on Tuesday, October 14th, with a meeting at 2.15 p.m., at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, W.C.2. A paper entitled "The Problems of the Development Worker," will be presented by Mr. F. W. McConnel.

EDUCATION DURING NATIONAL SERVICE.—A guide to the facilities available in the Army for occupational training and general education is given in a booklet, *Education During National Service* (H.M. Stationery Office, price 3d.). It indicates, for example, that there are 300 correspondence courses covering professional, technical and academic examinations up to intermediate degree standard.

THE PALLISER MAGNESIA WORKS.—The Ministry of Materials has announced that negotiations have now been completed for the resale of the Palliser Magnesia Works at Hartlepool to the British Periclase Company, a subsidiary of the Steetley Company, Ltd. The transfer took effect on October 1st. It is stated that the agreement under which the Ministry of Supply acquired the works in 1941 envisaged their eventual resale to the company.

B.E.A. RETIREMENT.—The British Electricity Authority has announced the retirement of Mr. J. W. Thomas, LL.B., from the position of Director of Training, Safety and Welfare. Mr. Thomas joined the B.E.A. in 1948 as education and training officer. Prior to that he was on the staff of Metropolitan-Vickers Electrical Company, Ltd., was a lecturer in electrical engineering at the Birmingham Technical College, and was, for a time, secretary of the British Engineers' Association.

SCIENTIFIC ADVISORY COUNCIL.—The Minister of Fuel and Power has appointed Sir George Thomson, F.R.S., to be a member of the Scientific Advisory Council, which was set up in 1948 to advise him on the scientific aspect of his statutory duties. Sir Charles Goodeve and Professor S. Zuckerman, C.B., F.R.S., have ceased to serve on the council. Sir Charles has resigned because of other commitments, and Professor Zuckerman's term of office has expired.

NEW ORDNANCE SURVEY MAP.—The Ministry of Agriculture states that a new Ordnance Survey 1 in map of Great Britain, the "Seventh Series," will gradually replace the current editions. The first of the new sheets are already on sale, but it will be some years before the whole country is covered by the new style map. Many improvements have been incorporated in the new edition, including the use of grey for tree symbols, house fillings and grid lines, and a separate colour for Class II roads. The result is both a clearer picture and a more easily read map.

RELAXATIONS IN METAL CONTROLS.—The Minister of Supply has announced further relaxations in metal controls. As from October 1st licences are no longer required for the acquisition and use of lead, lead alloys, lead scrap and residues, remelted zinc, zinc alloys, zinc scrap and residues, copper scrap and residues, and copper alloy scrap and residues. Licences are still required for the acquisition of unwrought copper and virgin zinc, and copper and zinc ores and concentrates. The restrictions on the use of copper and copper alloys in the manufacture of certain articles remain in force.

EUROPE'S COAL AND COKE DISTRIBUTION.—The coal trade sub-committee of the United Nations Economic Commission for Europe has recently agreed on the distribution, during the fourth quarter, of 13,600,000 tons of European solid fuel to nineteen European countries. The export programme for October, November and December includes 10,500,000 tons of European hard coal, patent fuel and brown coal briquettes, as well as 3,100,000 tons of coke. These figures do not include a further 2,000,000 tons of solid fuel which will move as an exchange between France/Saar and western Germany.

THE BENEVOLENT FUND OF THE INSTITUTION OF ELECTRICAL ENGINEERS.—The annual report of the Court of Governors of the I.E.E. Incorporated Benevolent Fund shows that the amount of subscriptions and donations has decreased from £13,057 in 1951 to £11,245 in the year ending June 30, 1952. At the same time, there has been a marked increase in expenditure, one factor being a rise of £1281 in the amount of grants ; there was also a loss of £1865 on the sale of investments to provide additional capital required for the development of "The Chesters" estate. During the year under review the expenditure of the fund exceeded the income from subscriptions by £2511. It is significant that an annual subscription of, say, 5s. from each of the members of the Institution who do not at present subscribe to the fund would increase the income by more than £6000.

INDUSTRIAL BOILER PLANT.—A conference on "The Operation and Maintenance of Industrial Boiler Plant," which is being organised by the Combustion Engineering Association, will be held at the Grand Hotel, Harrogate, on Tuesday and Wednesday, October 21st and 22nd. The first day's proceedings will begin at 10 a.m. with an official welcome by the Mayor of Harrogate, after which there will be a session to discuss "The Boiler Plant—Its Control and Maintenance." In the afternoon, at 2.30 p.m., the subject for discussion is "The Men in the Boiler House." On Wednesday morning, beginning at 9.45 a.m., the conference will consider "The Utilisation of Waste Heat," and at the final session, at 2.30 p.m., the subject for discussion is "Firing." The conference fee is £2 2s., and attendance is open to anyone interested in the subjects to be discussed. Full particulars and application forms can be obtained from the Combustion Engineering Association, 6, Duke Street, St. James's, London, S.W.1.

INSTITUTION OF HEATING AND VENTILATING ENGINEERS.—The next examinations of the Institution of Heating and Ventilating Engineers will be held during April (Section A) and May (Section B). Candidates who have already submitted proposal forms for membership and have been accepted as examination candidates must submit an examination application form before February 28, 1953 (January 31st for overseas candidates). Candidates who have not previously made application are first required to submit proposal forms for membership, and these must be considered by the committee before permission to enter the examination can be granted. Such proposal forms must be received by the Secretary not later than December 31st next and no guarantee can be given that proposal forms received after that date can be dealt with in time to enter approved candidates for the 1953 examinations. Students and Graduates of the Institution are not required to submit a transfer application form, as they are permitted to enter for the appropriate portion of the Associate Membership Examination (Section A or Section B) on submission of a completed examination application form before February 28, 1953.

"BRITAIN AWAKES."—We recently attended the preview of an industrial film entitled "Britain Awakes," which has been made by the Big Six Film Unit, 35, Endell Street, London, W.C.2, for Harry Ferguson, Ltd., Coventry. The film depicts the production, from start to finish, of the Feaguson tractor, including the manufacture in different engineering establishments in the country of the various components and their ultimate assembly in the Banner Lane Works at Coventry. The commentary on the film has been provided by Mr. Lionel Marson. In addition to showing the progressive stages of tractor production, the film emphasises the Ferguson incentive payments scheme which, it is claimed, has added considerably to the productivity of the works. Mr. Harry Ferguson, in welcoming a large and representative company of guests to the preview of the film, explained the incentive scheme in some detail. He said that the scheme started from the proviso that it was not an economic proposition merely to increase a man's money, but that it was one to increase his money if he worked harder and his pay packet became larger because he had earned it. The scheme for incentive payments allowed every employee to earn more provided the time taken in making the tractor was less. The film, "Britain Awakes," it should be added, is available for showing in 16mm and 35mm sizes.

Personal and Business

DUNLOP, Ltd., announces the retirement of Major F. Monk, chief safety officer.

MR. D. E. CLANCEY has taken up an appointment in the Johannesburg offices of Matthew Hall (Pty.), Ltd.

THE NATIONAL COAL BOARD has announced the retirement of Mr. Tom Smith, labour director of the North-Eastern Division.

BALFOUR, BEATTY AND CO., Ltd., states that Mr. O. M. White, M.I.E.E., A.M.I.C.E., chief engineer, has been appointed a director.

MR. WILLIAM BRUCE has been appointed sales engineer for London and the Home Counties of Opperman Gears, Ltd., Newbury, Berks.

CHAMBERLAIN INDUSTRIES, Ltd., states that the address of its Scottish representative, Gerard Wakeham, Ltd., is now 1, Clifton Street, Glasgow, C.3.

W. T. HENLEY'S TELEGRAPH WORKS COMPANY, Ltd. announces the opening of a new store depot at 4, Richmond Ope, Richmond Street, Plymouth (telephone, Plymouth 5759).

MR. C. E. PROSSER has been appointed deputy-chairman of the Metals Division of Imperial Chemical Industries, Ltd. Mr. M. J. S. Clapham has succeeded Mr. Prosser as joint managing director, Metals Division.

MR. MALCOLM MCDOUGALL has been appointed an additional member of the Development Areas Treasury Advisory Committee in succession to Major Jackson Millar, who has resigned owing to pressure of other business.

DORMAN LONG AND CO., Ltd., Middlesbrough, states that Mr. G. E. Chicken and Mr. C. Hipwell have been elected directors. Three senior officials of the company—Mr. S. Barlow, Mr. James Jack, and Mr. J. H. Patchett—have been appointed special directors.

MARCONI'S WIRELESS TELEGRAPH COMPANY, Ltd., Chelmsford, has reorganised its aeronautical division to include technical, sales and contracts sections. Dr. B. J. O'Kane, A.M.I.E.E., has been appointed chief air radio engineer, Mr. R. R. Stanford-Tuck has been appointed sales manager, and Mr. F. Wheeler, contracts manager.

British Patent Specifications

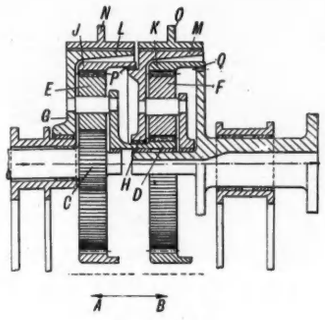
When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification.

Copies of specifications may be obtained at the Patent Office Sales Branch, 15, Southampton Buildings, Chancery Lane, W.C.2, 2s. 8d. each.

POWER TRANSMISSION

678,101. November 30, 1949.—TWO-SPEED GEARS, Peter Herbert Cleff, formerly of 2, Fernwood Road, Jesmond, Newcastle on Tyne, 2, now of Cleugh Brae, Jesmond Park East, Newcastle on Tyne, 7, and The Parsons and Marine Engineering Turbine Research and Development Association, of Pametrada Research Station, Wallsend, Northumberland.

This invention relates to two-speed gears having no idling parts: it is intended for dealing with large horsepowers and embodies high reduction ratios where consideration has to be given to the weight, the space required, simplicity in design and manufacture, reliability in operation and ease of maintenance for marine power plants. As the drawing shows, there are provided two epicyclic trains consisting respectively of sun pinions *C* and *D*, set of planet wheels *E* and *F*, planet carriers *G* and *H*, annulus *J* and *K*, brake drum *L* and *M*, and brakes *N* and *O*. The brakes are attached to the



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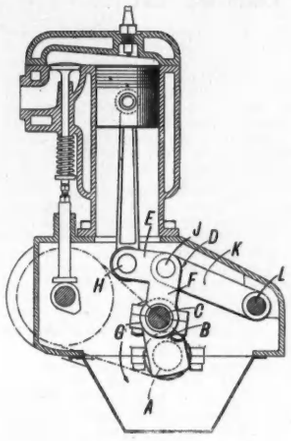
gearcase and act upon the respective brake drums *L* and *M*, of which the former is integral with the planet carrier *G* and the latter with planet carrier *H*. Sun pinion *D* is rigidly mounted on an extension of planet carrier *H*, whilst this planet carrier is connected to the primary annulus *J* by means of a fine tooth coupling ring *P*. The secondary annulus *K* is carried on a flange of the driven shaft, the connection between them being effected by another fine tooth coupling ring *Q*. The two speeds are obtained in the following manner: application of brake *N* renders planet carrier *G* and secondary sun pinion *D* stationary. The first train operates as a star reverse gear, the primary pinion *C* driving through planet *E* on to the annulus *J* reversely, which through planet carrier *H* causes the annulus *K* and consequently the output or driven shaft to rotate reversely at a speed V_1. The releasing of the brake *N* and application of brake *O* makes planet carrier *H* and annulus *J* the stationary members. Rotation of the driving shaft or primary sun pinion *C* causes forward rotation of planet carrier *G* and secondary sun pinion, which latter then drives reversely over planets *F*, the annulus *K* and the driven shaft, thus giving the second reversed speed V_2.—*August* 27, 1952.

INTERNAL COMBUSTION ENGINES

678,677. April 9, 1951.—A CONNECTING-ROD ASSEMBLY, Leon Harvey Femons and Laura Reynolds Femons, 1495, West Harding Way, Stockton, California, U.S.A.

The engine construction is clearly shown by the drawing. It will be seen that the crankshaft *A* is offset laterally from the axis of the cylinder with a crank *B* having a crank pin *C*. *D* is a bell crank lever with legs *E* and *F*. The leg *F* of the bell crank lever is coupled, at its free end, to the crank pin by a bearing *G* and extends from the crank pin substantially vertically or parallel to the longitudinal axis of the cylinder. The other leg *E* of the bell crank lever is coupled, at its free end, by a cross pin *H* to the lower end of the connecting-rod. The direction of rotation of the crankshaft is indicated by an arrow, and it should be noted that the leg *E* of the bell crank lever projects from the leg *F* generally in the direction of the rotation. The legs are substantially the same length. The bell crank lever is pivotally connected, at its elbow, by means of a cross pin *J* with one end of a rigid link arm *K*. The link arm extends from the bell crank lever in a direction generally opposite the leg *E*, and at its outer end the link arm is mounted by a cross pin *L* secured by a boss to the crank case. With the connecting-rod assembly described a very beneficial and effective leverage or thrust is attained upon the downstroke of the piston and connecting-rod, by reason of the fact that the crankshaft is laterally offset relative to the axis of the cylinder. Additionally, the combination of the bell crank lever *D* and link arm *K*, as mounted with the three-point connection, results in the crankshaft turning through



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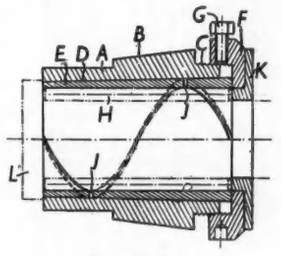
approximately 240 deg. on the power stroke and approximately 120 deg. on the exhaust stroke. In other words, the piston travels twice as fast on the exhaust stroke as it does on the power stroke. With the arrangement the engine has a low idling speed and quick pick-up, with maximum power in relation to its displacement. The connecting-rod travels generally in a straight path with little swinging motion about the axis of the gudgeon pin. The result is that wear between the piston and cylinder is minimised.—*September* 3, 1952.

BEARINGS AND SUPPORTS

678,277. March 28, 1949.—NEEDLE BEARINGS, Usines Tornos Fabrique de Machines Mautier S.A., Mautier, Switzerland.

The invention relates to an improved type of needle bearing with a device to take up the play caused by the wear. The bearing shown in the drawing consists of an outer body *A* with a conical portion *B* to allow its mounting in a corresponding support. The outer body is provided, at one end, with a thread *C* and a slightly conical bore *D*, wherein the sleeve *E* is to be lodged. The sleeve is slightly tapered and fits into the conical bore, in which it is held by means



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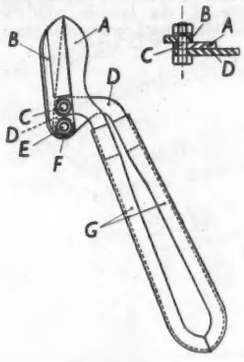
of a clamping nut *F* screwed on the thread *C* and provided with a locking screw *G*. The inner cylindrical bore of the sleeve *E* forms the outer rolling path for the needles *H* (shown in dot and dash lines). In the body of the sleeve there is a helical split *J*, the pitch of which is equal to the length of the sleeve. The needles are maintained between two stops constituted by a washer *K*, the inner shoulder of which revolves freely within the nut *F*, and by a ring *L*, shown in dot and dash lines. The device operates as follows:—As soon as a radial play of the parts is caused by wear the screw *G* is loosened and the clamping nut *F* then tightened to push upon the split tapered sleeve *E*, which, on being pushed into the interior of its conical housing, has its inner diameter reduced.—*September* 3, 1952.

TOOLS AND WORKSHOP APPLIANCES

678,129. March 12, 1951.—SHEET-METAL WORKERS HAND-SHEARS, Kenyon Barnett Butler, 5, College Yard, Worcester.

With reference to the drawing, top and bottom blades *A* and *B* are joined together at fulcrum *C*. Blade *A* is a running fit between lever *D* and blade *B*. Lever *D* is connected to fulcrum *C* and extends to the rear to be joined to blade *B* at point *E* using a distance piece *F*. The top of both blade *A* and lever *D* terminate in handles *G*. The handles are set at an angle to the shearing edge of blade *B*, so that the



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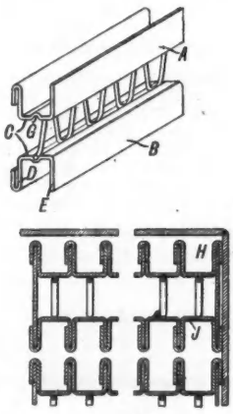
operator's hand is clear of top edge of sheet when shearing. By this invention it is claimed that large sheets of metal or like material can be sheared without the necessity of having to open out the sheared edges in line with the sheet surfaces to clear the handles or cutting blades.—*August* 27, 1952.

HEAT EXCHANGERS

678,352. January 18, 1951.—HEAT EXCHANGERS, The Air Preheater Corporation, 60, East Forty-Second Street, New York, 17, U.S.A.

In the upper view, *A* and *B* are a pair of metallic channels mounted so that the outer faces of their bases *C* face each other with their peripheries registering. Mounted between the bases of the channel members is a metallic wire bent to sinusoidal form so that the leg portions of the loops extend backwards and forwards between the bases *C* of the channels, while the intervening stretcher portions of the loops are welded to the channels. The bases



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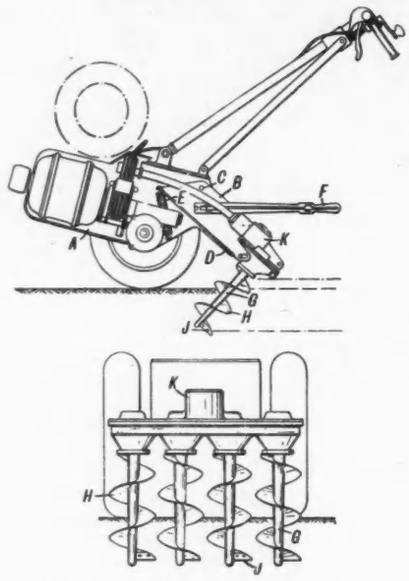
C of the channels may be formed with grooves or recesses *G* to receive the stretcher portions of the sinusoidal loops. The leg portions of the loop thus form fins that constitute extended surface for the channel bases *C* that form parts of the walls bounding the air-gas passages *H* and *J* of a heat exchanger when a number of these components are joined to form a unit for a heat exchanger as illustrated in the lower view.—*September* 3, 1952.

AGRICULTURAL ENGINEERING

678,509. December 31, 1948.—A CULTIVATING MACHINE, Andre Marie Peuble, 7, Rue Meynadier, Paris 19, France.

The machine illustrated in the drawings comprises a main frame *A* which is supported by travelling wheels. This frame serves as a mounting for an electric motor on the forward end of the frame and a sub-frame *B* for the cultivating tools. The sub-frame is pivotally attached to the main frame at *C* and by the action of the tools in engagement with the soil is adapted to be drawn down against a supporting platform *D* against the action of a spring *E*. Normally the spring maintains the sub-frame in an elevated position with the tools clear of the ground so that the

machine may be propelled over the ground with the tools clear of the soil. A hand lever *F* is provided to force the points of the tools into the ground to initiate cultivation and this lever may be held in a number of positions so determining the depth to which the tools are permitted to bore. The tools each comprise a core or spindle *G* around which winds a helical blade *H*, the bottom edge being tipped with a hardened and renewable piece *J*. Four



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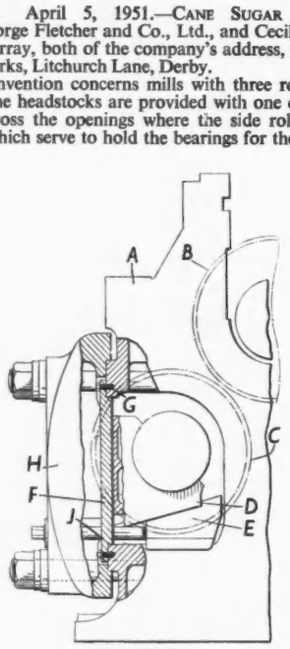
tools are arranged parallel to each other and in alignment across the width of the machine. The tools are driven in alternating opposite directions from the electric motor through a flexible shaft and suitable clutches, and the twist of the helical blades on the tools are opposite in direction for any two adjacent tools. The general arrangement of the machine and controls is shown in the drawing.—*September* 3, 1952.

MISCELLANEOUS

678,670. April 5, 1951.—CANE SUGAR MILLS, George Fletcher and Co., Ltd., and Cecil Walter Murray, both of the company's address, Masson Works, Litchurch Lane, Derby.

The invention concerns mills with three rollers in which the headstocks are provided with one or more bars across the openings where the side rollers are fitted, which serve to hold the bearings for the rollers



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in position during assembly and during dismantling. As the drawing shows, The headstock *A* is recessed at the top to receive a top roller *B* and at each side to receive a side roller, one of which is shown at *C*. The bearing for the side roller is shown at *D* and the lower face of the bearing block is inclined and rests on another inclined support or wedge *E*, so providing the vertical adjustment when the roller moves into the operating position. One or more retaining bars *F* are fitted vertically across the opening in the headstock and are secured to the headstock by bolts *G*. The cap *H* is fitted over the opening and recessed to accommodate the retaining bars, the bars themselves being shouldered on their inner faces so that they project slightly into the opening as shown at *J*. In a modified arrangement round retaining bars are shown, together with an additional shredder roller.—*September* 3, 1952.

Launches and Trial Trips

CARDIFFBROOK, raised quarter deck cargo vessel; built by John Lewis and Sons, Ltd., for the Williamstown Shipping Company, Ltd.; length between perpendiculars 250ft, breadth moulded 38ft, depth moulded to upper deck 17ft 9in, deadweight 2270 tons, draught loaded 16ft 11in, service speed 11 knots; three holds, steel hatch covers; Lewis-Doxford oil engine, cylinder diameter 440mm, lower piston stroke 820mm, upper piston stroke 620mm, 1100 b.h.p. at 145 r.p.m. Trial, September 16th.

LUCERNA, oil tanker; built by Smith's Dock Company, Ltd., for H. E. Moss and Co.; length between perpendiculars 500ft, breadth moulded 69ft 6in, depth moulded 30ft, deadweight 16,677 tons on 29ft 10¾in draught, service speed 13¼ knots; twenty-seven oil cargo tanks, two pump rooms, four 500 tons per hour oil cargo pumps, steam deck machinery; Hawthorn-Doxford two-stroke oil engine, five cylinders, 670mm diameter by 2320mm combined stroke, 5500 b.h.p. at 112 r.p.m., two Scotch boilers, two 50kW steam-driven generators. Trial, September.

WORLD ENTERPRISE, oil tanker; built by Vickers-Armstrongs, Ltd., Naval Yard, Walker, for World Tankers Corporation; length between perpendiculars 635ft, breadth moulded 86ft, depth moulded 45ft 9in, load draught 34ft 5in, deadweight 32,500 tons; thirty oil cargo tanks, one pump room, three 1000 tons per hour turbo-pumps; one set of double-reduction geared turbines, built by Parsons Marine Engineering Company, Ltd., 12,500/13,750 s.h.p., taking steam at 850 lb per square inch from two Foster-Wheeler "D" boilers, speed 16 knots. Launch, September 16th.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

ASSOCIATION OF SUPERVISING ELECTRICAL ENGINEERS

To-day, Oct. 3rd.—LIVERPOOL BRANCH: Liverpool Engineering Society, 9, The Temple, Dale Street, Liverpool, 9, "Television," B. P. Atkinson, 7.30 p.m.

Mon., Oct. 6th.—LEEDS BRANCH: Great Northern Hotel, Leeds, "Electrification in the Dales," Mr. Browell, 7.30 p.m.——N.E. LONDON BRANCH: Angel Hotel, Ilford, Question Night, 8.p.m.

Tues., Oct. 7th.—NOTTINGHAM BRANCH: E. Midland Electricity Board, Smithy Row, Nottingham, "The Permanent Way to Earth," F. Porter, 7.30 p.m.——W. LONDON BRANCH: Windsor Castle Hotel, 134, King Street, Hammersmith, W.6, "Catenary Cable Systems," A. J. Betts, 7.30 p.m.

Wed., Oct. 8th.—BRADFORD BRANCH: Midland Hotel, Bradford, "Electricity on Farms," Mr. Hack, 7.30 p.m.

Fri., Oct. 10th.—CREWE BRANCH: Copeland Arms Hotel, Glebe Street, Stoke-on-Trent, "Fluorescent and Cold Cathode Lighting," C. R. Bicknell, 7.30 p.m.

BRITISH INSTITUTION OF RADIO ENGINEERS

Wed., Oct. 8th.—LONDON SECTION: London School of Hygiene and Tropical Medicine, Keppel Street, W.C.1, annual general meeting, presidential address, W. E. Miller, 6.30 p.m.——N.E. SECTION: Institution of Mining and Mechanical Engineers, Neville Hall, Westgate Road, Newcastle, "Germanium Crystal Valves, Their Characteristics and Application," B. R. Bettridge, 6 p.m.

COMMUNICATION TRAINING CENTRE

Thurs., Oct. 16th.—Management House, 8, Hill Street, London, W.1, "The Presentation of Technical Information," Professor Reginald O. Kapp, B. C. Brookes and Alvin C. Leyton, 6 p.m.

ELECTRIC RAILWAY SOCIETY

Sat., Oct. 4th.—Fred Tallant Hall, 153, Drummond Street, London, N.W.1, "The Manx Electric and Snaefell Mountain Railways," J. H. Meredith, 3 p.m.

HULL CHEMICAL AND ENGINEERING SOCIETY

Tues., Oct. 7th.—Church Institute, Albion Street, Hull, "Some Chemical and Engineering Problems of the Fishing Industry," C. L. Cutting, 7.30 p.m.

ILLUMINATING ENGINEERING SOCIETY

To-day, Oct. 3rd.—BATH AND BRISTOL CENTRE: S.W. Electricity Board, Old Bridge, Bath, "Lighting for the Prevention of Industrial Accidents." E. W. Murray, 7 p.m.——BIRMINGHAM CENTRE: "Regent House," St. Philip's Place, Colmore Row, Birmingham, Chairman's Address, E. H. Norgrove, 6 p.m.——HUDDERSFIELD GROUP: Electricity Showroom, Market Street, Huddersfield, "Some Aspects of Department Store Lighting," A. W. Jervis, 7.15 p.m.

Thurs., Oct. 9th.—MANCHESTER CENTRE: N.W. Electricity Board, Town Hall Extension, Manchester, "Home Lighting," Miss M. D. Wardlaw, 6 p.m.

INCORPORATED PLANT ENGINEERS

Tues., Oct. 7th.—LONDON BRANCH: Royal Society of Arts, John Adam Street, Adelphi, W.C.2, "Fire Protection in Factories and Works," G. W. Underdown, 7 p.m.——S. WALES BRANCH: S. Wales Institute of Engineers, Park Place, Cardiff, "Plant Inspection as an Aid to Maintenance," 7.15 p.m.

Wed., Oct. 8th.—E. MIDLANDS BRANCH: Welbeck Hotel, Nottingham, "Protecting Your Plant from Fire," J. C. Elliott, 7 p.m.

Thurs., Oct. 9th.—NEWCASTLE UPON TYNE BRANCH: Roadway House, Oxford Street, Newcastle upon Tyne, "Manufacture of Glass and Some Aspects of Toughened Glass," D. Curran, 7.30 p.m.

INSTITUTE OF ECONOMIC ENGINEERING

Sat., Oct. 4th.—The Christian Institute, 70, Bothwell Street, Glasgow, "Methods," T. J. Haynes, 10.30 a.m.

Fri., Oct. 10th.—St. Ermin's Hotel, London, S.W.1, "Some Aspects of Methods Improvement," T. Stewart, 7 p.m.

INSTITUTE OF FUEL

Tues. and Wed., Oct. 28th and 29th.—Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1, Conference, "A Special Study of Ash and Clinker in Industry."

INSTITUTE OF PETROLEUM

Wed., Oct. 8th.—26, Portland Place, London, W.1, "Methods of Atomising Liquid Fuels," J. R. Joyce, 5.30 p.m.

INSTITUTE OF ROAD TRANSPORT ENGINEERS

Mon., Oct. 6th.—SCOTTISH CENTRE: Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, C.2, "Welding Methods," 7.30 p.m.

Tues., Oct. 7th.—EASTERN CENTRE: Albert Hall, Cowdray Avenue, Colchester, "The Running Maintenance of Fuel Injection Equipment," R. W. Preece, 7 p.m.

Fri., Oct. 10th.—S. WALES GROUP: S. Wales Institute of Engineers, Park Place, Cardiff, "Dieselisation," H. Parrish, 7 p.m.

INSTITUTION OF CHEMICAL ENGINEERS

Tues., Oct. 7th.—GRADUATES' AND STUDENTS' SECTION: S. WALES CENTRE: University College, Museum Avenue, Cathays Park, Cardiff, "Non-metallic Corrosion Resistant Materials," N. Monks, 7 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS

Mon., Oct. 6th.—S. MIDLAND CENTRE: Grand Hotel, Birmingham, Annual General Meeting and Conversazione. Chairman's Address, 6 p.m.

Tues., Oct. 7th.—S.W. SCOTLAND SUB-CENTRE: Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, C.2, Chairman's Address, J. S. Hastie, 7 p.m.

Wed., Oct. 8th.—S.E. SCOTLAND SUB-CENTRE: Heriot-Watt College, Edinburgh, Chairman's Address, C. H. A. Collyns, 7 p.m.——N. SCOTLAND SUB-CENTRE: Caledonian Hotel, Aberdeen, "Amenity and Hydro-Electric Schemes," L. B. Perkins, 8 p.m.

Thurs., Oct. 9th.—Savoy Place, London, W.C.2, Inaugural Address as President, B. H. Leeson, 5.30 p.m.——N. SCOTLAND SUB-CENTRE: Royal Hotel, Dundee, "Amenity and Hydro-Electric Schemes," L. B. Perkins 7 p.m.

INSTITUTION OF ENGINEERING INSPECTION

Tues., Oct. 7th.—Technical College, Coventry, "Jet Propulsion from the Pilot's Viewpoint," L. R. Stokes, 7.30 p.m.

Wed., Oct. 8th.—Church Institute, Albion Place, Leeds, Film "The Owen Organisation," speaker A. F. Rivers Fletcher, 7.30 p.m.

INSTITUTION OF MECHANICAL ENGINEERS

Tues., Oct. 7th.—AUTOMOBILE DIVISION: Storey's Gate, St. James's Park, Westminster, London, S.W.1, Annual General Meeting, Address by the Chairman, 5.30 p.m.

Wed., Oct. 8th.—GRADUATES' SECTION: Storey's Gate, St. James's Park, London, S.W.1, Discussion on "Surface Finish Measurement," J. Halling, 6.30 p.m.——LUTON GRADUATES' SECTION: Town Hall, Luton, "Some Problems of Gas Turbines," W. R. Hawthorne, 7.30 p.m.

INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS

Tues., Oct. 7th.—Institution of Electrical Engineers, Savoy Place, London, W.C.2, Chairman's Address, "Engineering and the Postal Service," 5 p.m.

INSTITUTION OF PRODUCTION ENGINEERS

Mon., Oct. 6th.—HALIFAX SECTION: White Swan Hotel, Halifax, "Increased Productivity by Workshop Practice," A. Cameron, 7.15 p.m.——W. GRADUATE SECTION: Grand Hotel, Bristol, "Some Trends in Production Engineering Education and Training," T. B. Worth, 7.30 p.m.

Wed., Oct. 8th.—BIRMINGHAM SECTION: Cadena Cafe, Worcester, "Interesting Set-ups on Modern Machine Tools," R. C. Fenton, 7 p.m.——COVENTRY GRADUATE SECTION: Geisha Cafe, Hertford Street, Coventry, "Factory Layout and Batch Production," "Flow Production," R. Gore, 7.30 p.m.——LIVERPOOL SECTION: Radiant House, Bold Street, Liverpool, "Steel—Engineers' Clay," F. Westall, 7.30 p.m.——NOTTINGHAM SECTION: Victoria Station Hotel, Milton Street, Nottingham, "Photo-Elasticity for Production Engineers," J. Ward, 7 p.m.——PRESTON SECTION: Crown Hotel, Market Place, Blackburn, "Substitute Materials and their Application," E. R. Gadd, 7.15 p.m.

Thurs., Oct. 9th.—ROCHESTER AND DISTRICT SECTION: Rotary Room, Sun Hotel, Chatham, "Jet Engines," E. E. Storm, 7.30 p.m.

Fri., Oct. 10th.—E. COUNTIES SECTION: Britannia Works Colchester, "The Corby Iron and Steelworks of Stewarts and Lloyds, Ltd." E. A. Taylor, 7.30 p.m.——STOKE-ON-TRENT SECTION: Works Visit to Josiah Wedgwood and Sons, Ltd., Darlaston, Stoke-on-Trent, 10.15 a.m.

INSTITUTION OF SANITARY ENGINEERS

Thurs., Oct. 9th.—Caxton Hall, Westminster, London, S.W.1, "The Sanitary Engineering Services for Pit Head Baths," J. H. Walton, 6 p.m.

INTERNATIONAL MACHINE TOOL EXHIBITION

To-day, Oct. 3rd, and Sat., Oct. 4th.—Olympia, London.

IRON AND STEEL INSTITUTE

Tues. to Thurs., Oct. 7th to 9th.—Special Meeting in Swansea.

JUNIOR INSTITUTION OF ENGINEERS

Fri., Oct. 10th.—Townsend House, Greycoat Place, London, S.W.1, "Electricity and Productivity," H. J. Gibson, 7 p.m.

SHEFFIELD METALLURGICAL ASSOCIATION

Tues., Oct. 7th.—Grand Hotel, Sheffield, "Metallurgy—A Partner in the Administration of an Integrated Steel Works," H. Humphries, 7 p.m.

SOCIETY OF CHEMICAL INDUSTRY

Wed., Oct. 8th.—CORROSION GROUP: Burlington House, Piccadilly, London, W.1, Discussion on "Filiferm Corrosion and Related Phenomena," 6.30 p.m.

SOCIETY OF ENGINEERS

Mon., Oct. 6th.—Geological Society, Burlington House, Piccadilly, London, W.1, "Refuse—Sewage Composting—Engineering Aspects," Hal Gutteridge, 5.30 p.m.